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CONTENTS

OF

THE QUARTERLY JOURNAL,

No. XXXV.

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TO OUR READERS AND CORRESPONDENTS.

Mr. T. Hamilton will observe that we have availed ourselves of his information.

The remainder of Mr. Bigsby's paper, with the illustrative engravings, will certainly appear in our next Number, the whole of his communication will thus be comprised in the same volume of this Journal.

We do not observe any thing sufficiently new in the process for obtaining Cinchonia, with which we have been favoured by our correspondent in Paris, to induce us to insert it in this Journal. The use of muriatic acid and magnesia was long ago suggested by Badollier, and answers the purpose, but we prefer sulphuric acid and lime. Our experience leads us to regard quinia, or at least its sulphate, as more certain and effective than the corresponding salt of Cinchoni. Its liability to adulteration we have long been aware of. A quantity recently imported from Paris contained 20 *per cent.* of sulphate of magnesia and sulphate of lime.

We refer our correspondent "on the Separation of Lime and Magnesia," to Mr. Davies' ingenious paper in the Annals of Philosophy for last August. We were not aware of the solubility of sulphate of magnesia, and the perfect insolubility of sulphate of lime in alcohol of the specific gravity which he adverts to, and have hitherto been prevented from submitting his suggestions to the test of experiment.

"Geber Secundus" has much amused us: we hope to hear more of him.

Several communications particularly intended for insertion in the present Number, reached us much too late. We again entreat our correspondents to forward all papers intended for immediate publication, *on or before the first days of December, March, June, and September.*

To a correspondent who consults us upon the subject of *Manure* we earnestly recommend a trial of coarsely-ground bones: his vicinity to the Metropolis renders the supply easy. We believe the application to be very effective and permanent.

We are quite indifferent upon the subject of the Edinburgh Controversy. E. S. knows that we long ago anticipated what has now come to pass, nevertheless we are obliged by his activity.

The system of re-printing papers published by learned societies is inconsistent with our plan, but F. R. S. E. will find a full report of the Essay he alluded to in our Eighth Volume.

"Geologicus" must address himself to the fountain-head.

The pencils sent us by Mr. Mitchell appear to be made of powdered plumbago and sulphur, the latter having been melted.

THE LECTURES,

IN THE LABORATORY OF THE ROYAL INSTITUTION,

Will commence on Tuesday, the 5th of October, at nine o'clock in the Morning precisely.

For a Prospectus see page 199 of the present Journal.

In the Press, and shortly will be Published,

A MANUAL OF PHARMACY,

By WILLIAM THOS. BRANDE, F.R.S. *&c.*

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OF

THE QUARTERLY JOURNAL,

N°. XXXVI.

TO OUR READERS AND CORRESPONDENTS.

Communications have reached us from Messrs. Hamilton and Crosby, and from Mr. James Mackenzie; but all too late for insertion.

We are not aware of any difference between the olive and the green oxide of manganese, adverted to by our correspondent at Cambridge. The sample enclosed in his letter is apparently a pure protoxide of manganese, without any trace of iron; we are, however, surprised that it should have been obtained by the process he describes.

In reply to the numerous queries that are put to us respecting new modes of tanning, new methods of making alcohol, steam-guns, gas-engines, and the like, we beg to assure VERITAS, AN OLD SUBSCRIBER, A CONSTANT READER, and other inquisitive persons, that although we form our own opinions we do not choose to promulgate them at present.

We cannot meddle with the complaints of "A Member of the Athenæum."

We are unable to offer even a plausible conjecture upon the questions referred to us by a "Proprietor of the London Institution;" nor can we give "Civis" any information, as we never even heard the people's names before.

As soon as the first twenty volumes of this Journal are completed, a very copious general index of their contents will be published, which will form a Supplementary Volume, and which, it is trusted, will be found a valuable acquisition to the scientific reader.

THE

QUARTERLY JOURNAL.

October, 1824.

Art. I. *Notes on the Geography and Geology of Lake Superior. By* John J. Bigsby, M.D., F.R.S., *and* M.G.S.

[Communicated by the Author.]

THE following pages contain the substance of my notes on the geography and geology of Lake Superior, made in the summer of 1823, during two journeys between the Falls of St. Mary and the Grand Portage, on the north coast of that lake, an interval of 445 miles. These journeys occupied a period of six weeks, and were performed in a birch-bark canoe; a mode of travelling particularly favourable to minute observation, as it compels very frequent disembarkation, and a constant proximity to the shores.

I have rendered this communication more useful and complete, by introducing numerous detached facts from authentic private sources; and by adding, principally from Mr. Schoolcraft's * Narrative of Travels through the Great Lakes to the head waters of the Mississippi, a brief summary of the leading features of the south shore of Lake Superior.

For the accompanying map †, I return my best thanks to David

* Indian agent for the United States at the Falls of St. Mary. I acknowledge, with great pleasure, the personal attentions of this gentleman, and his liberality in the interchange of geological facts.

† See Plate I.

Thompson, Esq.*, who constructed it in 1822, by order of the commission to which he is attached, from draughts made with the compass and Massey's patent log, and corrected by frequent observations, for latitude and longitude. I need scarcely add that the maps of Lake Superior hitherto published are incorrect, both as to the outlines of its shores, and its geographical position on the globe.

Lake Superior (also called Keetcheegahmi and Missisawgaiegon in certain Indian dialects) is contained by the west longitudes 84° 18′ and 92° 19′; and by the north latitudes 46° 26′ and 49° 1′. It is placed to the south of, and near to, the ridge of high lands, which, stretching from the Rocky Mountains to Lake Superior, in broad diluvial plains and undulations, (now and then discovering secondary rocks,) divides the waters flowing into the Mexican Gulf from those of Hudson's Bay; and which proceeds from near Lake Superior, eastward to the coast of Labrador, in a continuous range of hills, consisting of the older rocks, usually denuded and shattered; and then constituting the northern dividing ridge of the Valley of the St. Lawrence.

From near the west-end of the lake this ridge (having here changed its character) is lost, on the south and east, in the elevations of the United States; but still affords a connected series of successively-descending levels, for the St. Lawrence, its lakes, and magnificent tributaries, the Ottawa and Saguenay rivers, and Lake Champlain.

Lake Superior occupies an irregularly oblong basin, whose length lies east and west, and amounts to 541 miles†, as ascertained by Mr. Thompson, with a patent log. This measurement commences from Point Iroquois, at the mouth of the river St. Mary, (communicating with Lake Huron,) passes on the outskirts of all bays, (except their breadth render the crossing dangerous,) and circumnavigating Point Keewawoonan, terminates at the mouth

* Astronomer to the Boundary Commission, under the sixth and seventh articles of the Treaty of Ghent.

† Always statute miles.

of the river St. Louis, at the Fond du Lac. The greatest breadth is opposite Peek Island, and is 140 miles. The sum of the courses round the lake is 1155 miles, always avoiding the bays, especially Black Bay, which is itself about 90 miles around.

This body of water may be considered to be 617½ feet above the surface of the Atlantic, and 52½ feet above Lake Erie*; of these 52½ feet, 30 are generally allowed to be the difference of elevation between Lakes Erie and Huron, and 22½ have been allotted to the ascent from Lake Huron to Lake Superior; *viz.*, four feet, by Major Long's† estimate, at the Nibish and Sugar Rapids, at either end of Lake George, and 18½ feet at the Falls of St. Mary, as measured lately by the engineers of the United States.

From all I can gather, no gradual diminution is taking place in the quantity of the water of Lake Superior. The contrary, in truth, might be presumed, from its receiving the contents of 220 rivers and brooks, some of great size, and from its possessing only one outlet. Sixty years, however, have produced no change at the Grand Portage, where such an event would be readily detected. The appearances on the coast indicating a drainage are owing to temporary and local elevations and depressions, caused by storms; and to the fluctuations attributable to the seasons. The effect of tempests in raising the level of certain parts of the lake is very considerable. In autumn, a westerly gale, lasting more than a day, will sometimes inundate the site of the storehouses of the Hudson's Bay Company, at the Portage of the Falls of St. Mary; and will raise the water 20 or 30 feet at Gargantua, Michipicoton, or the Otter's Head, places exposed to the accumulated force of waves travelling over 200 or 250 miles of unobstructed and deep water.

Respecting the depth of Lake Superior, I have little to offer. It is doubtless very deep, judging from the coldness of its

* Determined to be 565 feet above the tide water on the river Hudson, by order of the Commissioners of the Great Western Canal of New York.

† Of the United States' topographical engineers, and commander of several exploratory expeditions.

water*. Near high land, as in the neighbourhood of the island called "The Paté," soundings have not been obtained with a line of 100 fathoms.

Few observations have been made on the height of the basin of Lake Superior; and these are without much pretension to accuracy. The lowest point in the barrier is between Point Iroquois and Gros Cap; for it has given way there, with the consequent formation of the river St. Mary, its outlet. For several miles north and south of these promontories, the land at the present day is much lower than elsewhere, and does not exceed 400 or 500 feet in elevation, while the dividing ridge, (the side of the basin), on the north shore, is always from 1000 to 1400 feet high; as also are certain parts of the south shore, if not all.

The summit level *of water*, at the source of the West Savannah River, between the waters of the St. Louis and those of the Mississippi, has been estimated at 550 feet in Mr. Schoolcraft's Narrative; that source being 123 miles, by canoe route, from Lake Superior, and about 70 direct.

The highest water level on the old route to the Lake of the Woods, from the Grand Portage, is in lon. 90° 34′ lat. 48° 7′; about 24 miles direct from the nearest point in Lake Superior, and may be assumed at 614† feet.

* Numerous observations on the temperature of the water of Lake Superior, made by Major Delafield, in June and the early part of July, furnished an average of 44° Fahrenheit.

† Namely; from careful estimate, the west end of the Grand Portage is above Lake Superior

	Feet.
the west end of the Grand Portage is above Lake Superior	195
Perdrix Portage of Pigeon River	70
Pigeon River, Rapids	10
Portage into outward lake	30
——— Moose Lake	15
Great Cherry Portage	150
Muddy Portage	25
Little Cherry Portage	80
Culbut in Lake Rose	4
Portage into East Lake of the height of land	35
	614

I could not perceive either rise or fall at the Little New Portage, nor *at the Great New Portage.*

On the new route to the Lake of the Woods, from Fort William, Major Delafield* considers the highest water-level to be close to Cold Water Lake, about 50 miles direct from Lake Superior, and in lon. 90° 14′ lat. 48° 59′. Major D. has furnished me with the subjoined details; which assign to the spot, the height of 505 feet above the surface of the last-named lake†. At this place the neighbouring heights are about 200 feet above the small lake or pond; but at the corresponding point on the old route I found the land in steep woody ridges 400 and 600 feet high, interspersed with frequent precipices of great height and magnitude.

This height of land, including the tributary smaller lakes and rivers, is never very distant from the lake; and the remark may be extended to the lower lakes, Huron, *&c.* Making use of the best map of the vicinity of Lake Superior, that of Major Long‡, the sources of all the rivers on the south shore, are within 60 miles, measured in a straight line. Although the whole of this region is

* Agent for the United States, under the sixth and seventh articles of the Treaty of Ghent.

	Feet.
† Source of Cold Water Lake above the Lake - - - -	8
Descent from Cold Water Lake to Dog River - -	2
——— of Dog River to the first Portage - - -	11
Falls and Rapids of Portage du Chien. (From this, Lake Superior is visible) - - - - - - - -	200
Falls of Little Portage du Chien, 7 feet; thence to a demi-portage 20 feet, and rapids 3 feet - - - - - - -	30
From Demi-Portage to Knife Portage, 10 feet; Knife Portage Falls, 15 feet; next Portage Falls and rapids, 6 feet - -	31
Fall of Portage de Lésle, 10 feet; Rose Rapid, 8 feet; Portage Ecarté, 30 feet - - - - - - -	48
Descent from Portage Ecarté to Mountain Falls - -	25
The Mountain Falls - - - - - -	125
Eighteen miles of rapid on the Dog, or Kaministaguia - -	25
	505

These estimates are entirely conjectural, being founded on no other observations than those of the eye; their coincidence, however, with similar observations by others of the party, made at different times, render it probable that they do not differ materially from the truth.

‡ James's Expedition to the Rocky Mountains.

familiar to the Canadian and American fur-traders, the information respecting it before the public is meagre and inexact. On the north shore the interval between the lake and the summit level is variable. The source of the West Savannah River has been shewn to be 70 miles from the lake; those of the Nipigon, Peek, and Michipicoton rivers exceed that distance, while for a certain space west of the Grand Portage, the streams take their rise much nearer.

Having premised these general observations, I now proceed to the description of the more minute geography of Lake Superior. This will be conducted from the east along the north shore. The geology will be treated separately, for the sake of clearness and easy reference.

Travellers usually enter Lake Superior by the River St. Mary, completing their equipments at the picturesque village opposite the "Falls of St. Mary," as the Great Rapids are styled. These are three quarters of a mile long, by about half a mile broad, the river being there narrowed by a broad tongue of land, protruding from the north shore, and affording a swampy site for the storehouses of the Hudson's Bay Company. Close below this contraction the river is a mile broad.

The rapids may be described in few words, as flowing swiftly in billows and broken whitened waters over a slope of ledges and bowlders, through a thickly wooded country, whose want of elevation has permitted the formation, on each side, of a number of islets divided by channels, which are narrow on the left, but much wider on the right bank. The bed and sides are loaded with large rolled masses, which can be traced with certainty to Lakes Superior and Huron. The right bank of the rapid along the lower half and below, varies from 10 to 50 feet in height, and is composed of light alluvial earth. This acclivity is more distant on the Canadian shore, and is of the same elevation; but is full of small rolled primitive masses.

The River St. Mary extends 16½ miles above these rapids. During the first six and a half miles, its low banks of marsh and wood are tolerably parallel, and from one to one and a half miles

apart. The trees are pine, maple, birch, elm, *&c.* The current ceases to be felt by boats two miles above the rapids.

A tongue of low land two and three quarter miles broad, projects from the north shore at nearly six and a half miles from the upper store of the Hudson's Bay Company; forming rather a deep bay on its east side, which is used as an harbour for schooners, and receives at its bottom a creek of some magnitude. This point, or rather tongue, (called Point aux Pins, from its prevailing tree,) is faced by sand-drifts and pebbles of greenstone and sandstone. It is itself almost wholly sand; and being low and wet, is in parts overgrown sparingly with aquatic plants.

From off this point, there is an extensive view, north-eastward, down the river. In front, is a broad sheet of water, flowing through woods, and disappearing at the Falls of St. Mary in a sunken forest, rendered grey by distance. On the left we have a line of blue hills, the continuation of those on the north shore of Lake Huron. On the right, nothing is visible beyond the river-bank.

From Point aux Pins the river widens rather suddenly, and at seven and a half miles westerly is terminated on the north by the south headland of Gros Cap, and on the south, by Point Iroquois; about six miles asunder. This part of the river is still surrounded by low land, except at the upper end, where on the north shore, the Huron Hills approach, while on the south it is contained by the heights which give off Point Iroquois. Banks and braches of reddish sand are here common, especially on the north; where they are sometimes 12 feet high. There is on that side of the river, a large and low islet of sand two and a half miles below Gros Cap.

At Gros Cap, Lake Superior is entered. The prospect from this place is in itself very beautiful, and becomes magnificent when aided by considerations of the remoteness, magnitude, and celebrity of this body of water. The spectator stands under shattered crags, 300 feet high, with an apparently boundless flood before him. A low island is in front. Point Iroquois is on the south, declining from a high tabular hill, and on the north and

northwest is somewhat faintly seen, a picturesque and elevated country.

The name of Gros Cap, I understand, includes the rocky hills constituting the north shore of Lake Superior from the River St. Mary for four miles, but which then suddenly sink into a rugged slope, buried under vegetation. Both extremities are well marked, and may be distinguished as the north and south headlands of Gros Cap. This line of hills consists chiefly of rocky knolls and crags, (with the usual ravines and fissures,) piled upon each other to the height of 150 or 200 feet at the north end, and about the middle; but to 400 and 450 feet, a mile or more from the south end, where they dip into the lake, from an elevation of 300 feet in advanced broken scraps, lowering successively. The greatest height above stated, is partly formed by precipices of porphyry fissured perpendicularly, and terminated below by slopes of ruins, which, at one spot, advance into the lake in a flat four or five acres in extent. Cliffs elsewhere are neither high nor frequent. In patches these hills are quite bare, but ordinarily they are covered with dwarf pine, aspen, and coppice. Near the north headland there is a fine but small cascade, dashing over rocks. A small rocky isle, rather more than a mile and a half from the south headland, should be mentioned. It is separated from the main by a shallow channel 50 yards wide.

The general course of the east shore of Lake Superior, from the south headland of Gros Cap to the River Michipicoton, (125 miles *,) is about a point west of north. The most conspicuous promontories in this interval are Marmoaze †, (41 miles from the south headland,) and Gargantua, (93 miles.) They are the outer points of great curvatures, which contain subordinate bays of very large size. The most southern of these, is Batchewine Bay, or Baie Gulé, of Canadian voyageurs. The north headland of Gros

* By canoe route, which, it is to be remembered, varies in length according to the weather, *&c.*

† A Chippewa word, signifying an assemblage, and here referring to islets and reefs.

Cap may be considered as its east limit; the western angle being a round flat cape, the end of a low tongue of woods a league broad, and extending eight or nine miles into the lake from the hilly ridges on the north. This bay widens somewhat within, and may be eight miles deep. It is bounded immediately by low lands covered with maple, birch, pitch pine, spruce, poplar, *&c.*, but on the north and east it has lofty ranges of hills.

On the outer or western side of the tongue above-mentioned, a few miles from the extremity, is placed the "Great Maple Island," flat and woody, the largest of a scattered group, called, the "Maple Islands." One of these, usually made for in fine weather by canoes from Gros Cap, is about three miles north-west of the point; and three others lie off the mouth of the bay next on the north, which contains Green Island, about a mile long, and of the same features as the Maple Group.

This bay is triangular in its shape, and is between four and five miles in diameter. Its shores are similar to those of Batchewine Bay. The flat north-west angle of the last described bay, crowded with spruce and poplar, is the south-east angle also of another bay, eight and a third miles across, and four miles deep. Its lower or south-east arm is lined with white sandstone in debris and in low ledges at the projections of the indents; but every other part is faced with sand banks, 10 and 20 feet high, and extending into the dense woods; which are backed by hills of imposing outlines, 700 and 800 feet high. A winding river about 50 feet broad enters at the bottom.

From the gently curving north point of this large bay, the shore continues for four and a half miles rocky, and moderately straight to Point Marmoaze; (Memince of the Voyageurs;) but it still has frequent coves, and one shallow bay, almost a mile in diameter, lined with sand banks. The interior is woody and rather low, but rises slowly. There are three or four islets, surrounded with reefs and broken mounds of rock near the point. Gros Cap and Whitefish Point on the south shore are in sight from hence. Between them is seen Point Iroquois, apparently an island. From Point Marmoaze the canoe route crosses a bay seven miles wide,

but only two deep. Its shores are rocky, but high on the northern half only, that being granite. Its north cape is a massive and lofty bluff of rock. It is followed by a second bay, three and a half miles across, with very high angles, and an elevated interior, but fronted with beaches of sand and beds of gravel. Its north point has a rocky isle in front.

Huggewong Bay (or Hoguart, as named in the French maps) now succeeds; it is 10 or 12 miles across at its mouth; the south side being eight miles long, and trending north-east, while the north side, running east, is about one-third of that length. Both meet the bottom of the bay nearly at right angles. Their immediate shores, except in certain places, rise suddenly in round-backed steep hills, precipitous and bold in parts, and from 400 to 600 feet high, with narrow woody dells between. Along the outer half of the south side, shingle beaches are common, many feet high, with extensive deposits behind them, of large and small bowlders of the rock of the district, imbedded in sand, confusedly and in horizontal layers. These banks, from 10 to 30 feet high, rest on the base of the hills, and sometimes extend inland a quarter of a mile.

The Montreal River, (whose vicinity several years ago was examined in search of copper, by order of an English Mining Company,) enters Huggewong Bay, in the middle of the south side, in a cove guarded by two narrow but high and naked bluffs, the north-eastern one being connected by sand banks to the main. This river is 150 feet across at the mouth, and issues with a current of three and a half miles per hour, from among beds of sand and gravel, which are high on the northern side only, and pass half a mile into the country. At one third of a mile from the lake, there is a fall 10 feet high, among dark overhanging rocks, n a hollow, between two conical hills.

The bottom of Huggewong Bay is faced with sand banks, which retire a mile or two inland in successive embankments. Besides two smaller streams, it affords an outlet to the River Huggewong, which is of considerable size, and near the lake, runs through low woods, but farther in the interior it occupies the

defiles of a very rugged country. At the south angle of the bottom there is a cliff 500 feet high, overlooking a terrace of siliceous sand. It is 30 feet thick, and is half a mile in length and breadth.

Off the mouth of this romantic bay, there is a flat and woody island, called Montreal or Hoguart Island.—It may be from three to four miles in diameter, and is rather nearest to the north cape of the bay, Point Huggewong.

This point (66½ miles from the south headland of Gros Cape) is round, and consists of bluffs and cliffs, dipping from shattered and round-topped eminences, 400 and 600 feet high. There are four rocky islets, with high sloping sides, off this point, exclusive of several small ones around an indent half a mile from the extreme point at the entrance of the bay. This indent is 400 yards wide, and is a good harbour for vessels, having safe anchorage, and great facility of access and departure.

From Point Huggewong to Gargantua *, the next very remarkable headland, the distance is 27 miles. The first fifteen miles are slightly concave, and subdivided into minute coves.—By far the greater portion of this space consists of deep and extensive beaches of siliceous sand, interspersed here and there with low ragged ledges of rock. The interior presents the same hills in height and features as those of Huggewong Bay. I ascended one about 600 feet high: but could not see any distance inland. The streams here are numerous: the principal are river Charon, (six miles from Point Huggewong,) and Gravel River, five miles N.W. from the river Charon). The Gravel river is 60 yards wide at the mouth but is very shallow there, except near the west bank. It has a fall a small distance from the lake, and derives its name from the large collection of pebbles and sand about it. Opposite this river there is a low woody isle; and off the Charon there are some smaller. A mile S.E. from Gravel river, the heights, 400 and 600 feet high, which had ranged along shore, but at some distance, dip into the

* Supposed to be derived from the word Gorgon.

water, at intervals, for three miles, in scarps and slopes. The remainder of the 27 miles to Point Gargantua is a ragged coast, chiefly of naked rock, backed by round hills of granite, which, near Gargantua, touch upon the Lake.

Point Gargantua is a prominent feature in the east side of Lake Superior. It has a very indented front; being composed of a great number of ridges from 20 to 80 feet high, closely grouped together, and from time to time broken by the waves and weather; leaving ragged perpendicular ends with coves between them, strewn with black sand. The granitic region, a mile in the rear, is destitute of vegetation, but the point itself (amygdaloidal) is clothed with small pine, birch, poplar, and a profusion of mosses. The river Gargantua issues at the bottom of a small bay, beset with isles, south of and contiguous to the point. I did not see it.

Gargantua Point has numerous islets scattered along its south side, for two or three miles; but they do not extend far into the lake. They are low and woody. At the south end, however, one presents a cliff 100 feet high. Intermixed with these islets and especially on their outside, are solitary high ridges in a state of ruin, and a vast number of small detached pointed rocks, scarcely rising above water. A pyramidal fragment of one of these ridges, 50 feet in height, situated a few hundred yards off the point, is an object of adoration among the Indians, and has given to the locality its name.

Point Gargantua may be very properly considered the south angle of the great bay of Michipicotan. The two sides of this bay, together with a line drawn across its mouth, forms a rude equilateral triangle, the north side and chord being 27 miles long, the south 25*, and the bottom four miles wide: the direction of the axis of the bay is north-east.

The south side is broken into several large bays; Capes Choyyé and Maurepas being the most important headlands. A lofty style of country prevails throughout the whole of this side; the hills

* I disregard here the curvatures which would affect the distance by canoe route.

rising by interrupted ledges, or in slopes covered with foliage, or in vertically-fissured precipices terminating in debris; the greater part wooded with slender pines and poplar. The immediate shores are chiefly defended by ledges of rock, which rise rapidly to from 100 to 500 feet high. At Cape Choyyé, for more than a mile the rocks are precipitous, and are furrowed by narrow and deep ravines:—but along the greater bays of this vicinity there are extensive deposits of sand and bowlders. All this neighbourhood is very picturesque, but especially the bay south of Cape Maurepas, a broad and steep mass of rocks. The shores of this bay abound in great irregularities of surface. On the south of its extreme depth, there is a beautiful cascade, in the distant woods, pouring a ribbon-like stream from one height to another, and so finally into the lake. This spot reminded me of some scenes in the Cape de Verd Islands.

The inner third of this side of Michipicotan Bay is comparatively straight, often in scarps, and very high in the interior. Three or four miles from the bottom there is a cape from which canoes usually cross to Point Perquaquia on the north side of the bay;—a headland projecting a mile from the usual line of coast, and about 400 feet high.

The bottom is principally sand, which passes a considerable way inland, as indicated by the smooth appearance of the country. The river (of which I know only that it is large, long, and the shortest route to Moose Fort, in Hudson's Bay) enters at its middle.

The north side preserves a pretty straight western direction; but is full of petty indentures, exclusive of the larger near Point Perquaquia. Its hills do not differ from those just noticed, except that they are further apart, and are not quite so steep. From the last-mentioned point to the Dog river (about 14 miles) the shore consists very frequently of sand-banks, always deep and extensive, and near this river, gravelly, 40 feet high and passing inland a short way. At its mouth the Dog river is 30 feet wide, being confined, at its entrance into Lake Superior, by rocks on one side, and a large bank of gravel on the other; but it immediately widens to 100 yards within that bank; again contracting in a short dis-

tance to 60 feet. One third of a mile from the lake it undergoes a descent of 25 feet, by two ledges, with moderate heights of greenstone slate* on all sides. From this river to the Crags of Michipicotan (8 miles), the shore is wholly ledges of rock, graduall ascending in the interior. These "Crags" as they have been called, now bound the lake for more than a league and a half westwards. They commence and terminate suddenly, and descend from hills 500 and 600 feet high, in bald shattered rocks 150 feet, and occasionally 300 or 400 feet high, always very steep, frequently precipitous, and seldom protected from the waves by beaches. At their west end these hills, turning northward, very slowly leave the lake side. Not far from this end of the crags, a dell of considerable beauty permits the escape of a noisy rivulet.

The Crags may be assumed as the north-west extremity of Michipicotan Bay, from their being strongly marked, and being the commencement of a gradual change in the direction of the coast.

A few miles outside of this bay lies the large island of Michipicotan,—Maurepas of the French geographers. At Gargantua it is lofty and blue in the horizon, and about 25 miles west; but it approaches the main on the north within less than half that distance, some miles beyond the Crags. It is from 15 to 20 miles long. Several high ranges of hills are visible in it. It is only visited by Indian hunters.

The interval of seventy-five miles between the Crags and the River Peek presents but two localities which have received generally known names, *viz.*, The Otter's Head, 34 miles; and the "Smaller Written Rocks," 61 miles from the Crags.

From the Crags to the Otter's Head the coast rounds gradually to the north-west. It is a chain of steep round hills from 100 to 400 feet high, naked, with the exception of a few withered spruce, and a denser growth of aspen in the hollows. The eminences are usually at a small distance from the edge of the water, which is contained by alternating beaches of sand (or shingle) and low ledges of rock, with here and there a steep islet in front of

* Direction N.N.W., dip vertical

a small headland. It is subdivided into very numerous bays and coves: one of the former, eight miles from the Otter's Head, being of considerable magnitude and chequered with woody islets. The depositions of sand in many of these curvatures are very large. They are visible from the lake, for half a mile or a mile into the interior; and certainly extend farther. This is especially the case from seven to eleven miles east of the Otter's Head, where, in places, the sand hills are 150 feet high in two or more steep embankments. The violence of the waves here also has thrown up vast heaps of angular debris, torn from the contiguous rock, 20 or 30 feet above water-mark, and has even scattered them among the trees. Near the lake, all the rivers run over alluvial bottoms, and are commonly shallow at their junction with it. They are small, as far as I am aware; there is one, however, in the large bay eight miles east of the Otter's Head, of some size, flowing in dark ravines, scantily feathered with shrubbery.

The Otter's Head is an erect upright slab, about 30 feet in length, placed on some rocks, 100 feet high, and at an interval from the lake, which, though small, is greater than it appears, as we learn in attempting to reach it. These rocks form a promontory which overlooks a deep but small cove, sheltered by a group of islets and rocks; one of the former is large and well wooded.

The coast between the Otter's Head and the Peek River, (41 miles long,) is more deeply indented than the space from the Otter's Head to the crags. Its hills are higher, more massive, and frequently dip precipitously into woody dells. The sand-beaches are fewer, nearly the whole margin of the water being of low naked rocks. About 21 miles from the Peek River there is a large arenaceous bed, 120 feet high, and passing inland. A river pours through it into Lake Superior, from a level and rather fertile country; but closed in the distance by granitic hills. A similar deposit exists in the bay south-east from this river, three-quarters of a mile wide, one mile and a half deep, but not more than 20 feet high.

The Smaller Written Rocks are about a sandy cove 14 miles

from the Peek River, defended by islets. The rocks here are smooth and covered with tripe de roche and lichens, on which persons have traced names and figures as at the Great Written Rocks.

The rivers of this interval are not remarkable. I do not know their names. About three miles and a half from the Otter's Head, a moderately large river descends into the lake by three slanting falls, into which the stream is divided, close to the lake, by two high crags. Above these three channels is a small basin, into which the river pours from a still higher level; the whole descent being about 50 feet. It is a very lively and interesting scene.

The River Peek takes its name from an Indian word, signifying mud; as it pours out an ash-coloured, and when swollen, a reddish yellow water tinging the lake for a mile or two around, and derived from certain beds of white and yellow clay. Eighty yards broad at its mouth, (but soon after, widening for a short space to 200,) it issues with a gentle current at the south-east end of the bottom of Peek Bay, a straight line, half a mile long, of sand drifts, tufted with pines. For 90 miles inland, this river flows slowly and equably, with frequent bends, and a breadth the same as at the mouth: its banks and vicinity throughout most, if not all, of this distance, are of sand and large beds of clay, principally white; which, although narrower higher up, near Lake Superior, are little short of a mile broad, in low undulations, and girded on both sides by greenstone heights. At the above distance of 90 miles is the first fall, succeded by two others, the third being 120 miles from Lake Superior, and passing through a sand hill 200 feet high, over which a portage is made by traders. This last fall is high and has worn its way to the primitive rock beneath the sand. Shortly above this, the river divides into three small branches. The Peek River is the usual route to Long Lake, 180 or 200 miles from Lake Superior, by the circuitous route in canoes. After leaving Peek River, a series of brooks and ponds leads to the lake, ranging nearly parallel with Lake Superior, and 75 miles long, but only from half a mile to a mile

broad. It is on, or near, the height of land. On its north, at no great distance, is Little Long Lake, narrow, and 20 miles long*.

At the mouth of Peek River, the Hudson's Bay Company have a fort; a picketted square, formed by the superintendent's house, other dwellings and warehouses.

Peek Bay is rather more than two miles and a half in breadth, and about half that depth. Its south arm is a moderate concave line, but that on the north leaves the bottom of the bay by a right angle, as a straight headland of woody steeps faced by seven thickly-timbered islets. From this point the coast of Lake Superior for six miles and a half, (with indents at the south end,) trends N.b.W.½W. to another headland, faced by lofty casque-shaped islets; this interval being chiefly a high beach of shingle, backed by a deposition of sand and gravel, in several levels, which frequently unite. The height of this bank at the east end is 50 feet, but at the west end 100 feet.

Seventeen miles and an half by canoe route from the Peek River is Peek Island; placed opposite to a lofty and broad promontory of deeply-fissured rock. I can only add that it is several miles in circumference, and has at least two naked, rounded summits, the highest of which attains an elevation of 600 feet. The shores of the lake to this promontory from the casque-shaped islets are broken into deep bays, overlooked by pleasingly-grouped hills of conical or undulating outlines from 600 to 800 feet high, which dip into the lake in precipices or shattered slopes. About three miles north-east of Peek Island is a small cluster of bare islets close to another high cape, the west end of a long traverse.

This bay north-west from Peek Island is nine miles across at its mouth, and is of great depth. A round islet of greenstone near its middle, is of great use in rough weather, as a place of refuge for canoes. Its hills are in broad flanks 800 and 900 feet high. The bay is full of minor curvatures. A well sheltered and very convenient cove with a narrow entrance, a little within its western cape, has given to that angle, the name of "Cap a l'ance de

* For these particulars I am obliged to Mr. M'Tavish, Superintendent of Peek Fort.

Boteille." The wall of rock constituting this cape rather exceeds two miles in length. It is crowned with pine woods, and is backed by an interior range of eminences. It terminates in a cove darkened with high cliffs, and receiving at its bottom a slanting cascade. This cove is succeeded on the west (the general direction of the coast from the Peek to Gravel Point being west) by a large and irregular bay, whose east side is a massive greenstone height, but the bottom and west side consist of alluvial banks from 60 to 70 feet high, resting on greenstone. Rounding the obtuse west angle of this bay we come into another, whose east side is a shingle beach fronting a deposit of sand and gravel, which for one-third of a mile inland is a barren flat; and then rises in two terraces to 80 or 100 feet, which, however, approach the lake at the east angle of the bay. The west side of this bay is a high shelving cliff, bending round into the usual course of the coast suddenly; and so passes on to the Black River, in broken rocky shores, interspersed with beaches of sand.

Of the islands nearly opposite to, and about seven miles from, the Black River, named by Mr. Thompson "The Slate Islands," from their being composed of greenstone slate, I only know that they are large and high. Lieutenant Bayfield, R.N., has examined them.

The Black River, rising near Long Lake, noticed in p. 17, enters Lake Superior on the west side of a bay of moderate dimensions, with a rocky islet or two on its outskirts. A hill of bleached granite, 300 feet above Lake Superior, about one mile and a half distant, and being at the same time not far from the river, affords a good prospect of the adjacent country. Five or six miles on the north, a line of rather high hills, intersected by occasional defiles, ranges parallel with the lake. Their base for several miles, east and west, (as far as the eye can reach,) is buried under a deposit of gravelly sand *, bearing mosses and a few small firs, and stretching down to the lake side, now and then pierced by a knoll of granite. The arenaceous plain is 170 feet thick near the

* Consisting of very small pebbles of greenstone, granite, and quartz, in a dark brown coarse sand.

lake, and on the east of the Black River lowers in six banks, whose summits always have a slight inclination towards the lake. Their number, however, varies by the occasional coalescence of one or more. Close to the river, several of the lower levels are lost in one great steep, which includes a bowl-shaped cavity three-quarters of a mile in diameter, open in the direction of the Black River and Lake Superior, but at present being somewhat higher than either. It is a deserted bay.

The Black River, having for some miles previously flowed 50 feet broad, in a deep alluvion with three large embankments, indicating as many distinct conditions, makes an elbow round the height, from whence the above-described scene is beheld, and then undergoes a series of descents until it arrives at the lake, one mile and a half distant. The first fall above alluded to is premised for 350 yards by several low cascades from three to six feet high, a large granitic height being close at hand on the west also. This fall is 60 feet high, and 15 feet broad at the brink, pitching into a deep funnel-shaped chasm of mural black rocks, which although broader above, is not more than 10 or 12 feet wide at the bottom. A channel contained by high walls, 250 yards long, now conveys the water to three falls of much beauty, each 12 feet high, two of them being on the same level, at lower corners of the small basin which succeeds the above channel. Escaping from the inferior of these falls, the river passes on at the rate of a mile and a half per hour toward the lake, with scarps of sand 150 feet high, in two branches, enclosing a fertile oval islet a quarter of a mile in diameter. In a few hundred yards after the re-union of these branches, another succession of petty cascades occurs, which terminates in very picturesque falls about 20 feet high, of considerable width, and subdivided into several unequal portions by an isle, and by tufts of fine larch, spruce, alder, cedar, *&c.*, which isle continues into a basin, that now occupies the interval of one-third of a mile from the lake. These last falls are confined by woody overhanging rocks, on the west, and by a sand bank on the east side. The basin communicates with Lake Superior by a cut 80

feet broad at the west end of the sandy beach forming the bottom of the bay.

The Written Rocks, chiefly worthy of notice as a point of reference, are rather more than four miles west of the Black River, the intervening shore being both alluvial and rocky. They are a cluster of islets close to a large promontory, the east cape of a bay, about two miles broad; and are separated from the main by a narrow passage, not quite a mile long. They have received their name from the drawings figured on the flat surface of the rocks, simply by detaching the dark lichens which grow on them. At their west end there is a fair representation of an Indian firing on two animals.

The low intervals of the main about the Written Rocks are tolerably wooded, but the other parts very sparingly. Hereabouts the rocks have a very glaring appearance, from their weathering bright red. They are lofty, but shattered. The first bay west of the Written Rocks is surrounded by high land, particularly on its west side, where it attains an elevation of 800 feet towards the bottom. From its west angle there is a straight line of ruined cliffs for 1850 yards, a dangerous pass for canoes during certain winds. It ends abruptly at Cape Verd, by the main turning to the north; but speedily resuming a westerly course. Two or three miles to the west of Cape Verd are the isles of the Pays Plat.

From Cape Verd westward to Fort William, the coast is divided into three very large bays, Nipigon, Black, and Thunder Bays, parted by great headlands.

The first of these, Nipigon *, properly so called, instead of being confined to the great curvature near the river of that name, may, with greater justice, be extended from Cape Verd to one of the points near Gravel Point, about 36 miles apart, in a straight line, trending south of west, but 46 miles along the canoe route to Fort

* The district which I have included under this appellation is named by the voyageurs "Pays Plat;" with what reason I am at a loss to discover; as it is high and rugged. The name may refer to the shallows outside of the island of St. Ignatius.

William, outside of the islands. Both these assumed angles are well marked. The bay deepens gradually to the west, being, near Cape Verd, from four to six miles deep; and at least 16 miles deep near the river Nipigon. Its mouth is crowded with large and small islands in a dense belt, leaving the body of the bay comparatively free; not but that occasional isles are sprinkled there also, and chiefly about the west end. These are both flat-topped and conical, from 100 to 300 feet high, and surrounded with low girdles of luxuriant verdure. One remarkable island has received the name of "La Grange," from its resemblance to the long and narrow barns of the Canadian peasantry. The main land everywhere maintains a great elevation, sometimes amounting to 1000 and 1500 feet, as I am informed by Lieutenant Bayfield, R.N., and as my own remarks lead me to believe. It is often in high platforms; and usually very naked.

I cannot give a very precise account of the number and situation of the islands at the mouth of the bay. They are more numerous than as set down in the accompanying map, which was drawn up by Mr. Thompson previous to the complete examination of the coast. I have ventured to insert from my own notes and from authentic information, a general sketch of the main and islands. I have circumnavigated the latter rapidly, as a group, but not individually. The most westerly island (called by the French, "St. Ignace") is the largest. Lieutenant Bayfield found it to be 50 miles round. Its length runs nearly east and west, and much exceeds its breadth. Its greatest height is along the middle, where probably a sort of table-land exists, dipping on all sides in rough declivities, and frequently in precipices, whose features change with the component rock. If this be porphyry, the cliff is fissured vertically in long pilasters, beginning at the crest of some steril height, and sustained below on a slope of ruins. These cliffs are seldom straight for any length, but follow the capricious and serrated outline of the hills and shores, with deep ravines of loose rocks between. This form of coast prevails on the south part of St. Ignatius, and is well seen at the Detroit, on its outer side, (about long. 87° 48',) formed by an

isle or two. There brown and red porphyry form, in the interior, cliffs 350 and 450 feet above the surface of the lake, and also another series, dipping into it from an height only of 25 and 50 feet. The sandstone precipices abounding on the north side of this island are only in patches at the summit of steep flanks, and seldom extend downwards more than 50 feet, the rest of the descent being woody. On some of the islands east of St. Ignatius, these cliffs however reach the water, with fretted crumbling fronts, and the parts accessible to the waves often scooped into small caverns, supported on low arches, like those in Grand Island on the south shore, but on a much smaller scale. This kind of cliff runs in right lines, fissured by water-courses from above, and tufted with coppice.

From the east end of this large island to Cape Verd there succeed four principal islands, all very much smaller than it, and surrounded by islets and rocks. On their north shores, the sandstone cliffs show themselves with their characteristic outlines; but their south shores are chiefly low, shelving, and often naked terraces of amygdaloid, with beaches of black sand. Now and then, especially about the middle of the Pays Plat *, these terraces become precipices 150 and 250 feet high. Near the Detroit before alluded to, and on its west for several miles, the shores are extremely shallow for some way into the lake. The interior is there low, with high beaches of angular debris. The country resting on amygdaloid is very thickly wooded, but the trees, mountain ash, spruce, poplar, birch, pitch-pine, are hide-bound, and, as it were, smothered, under the moss called goat's-beard. Canoes in journeying on this coast, pass on the north of this insular group in autumn, entering from the west by the strait from one to two miles broad, and about six long, marked the "Nipigon Route;" in summer, the outer and shorter, though less sheltered, course is chosen. The Nipigon † River enters the bay at its west end. It is from 80 to 100 yards broad at the mouth, and discharges a muddy grey water. It is 90 miles long, and has seven

* I apply this term to the outside of this belt of islands.

† Also called Alempigon, or Red-stone River.

cascades, and three rapids; the first of the former being nine miles from Lake Superior, and the largest only 15 feet high. It issues from a round lake, 60 miles in diameter, in a barren country of low primitive rocks. In Canada this lake is chiefly known by the name of "Nipigon," but the servants of the Hudson's Bay Company call it Lake St. Anne. I learnt the above particulars from Mr. Mackenzie, Superintendent of the Hudson's Bay Company's Fort in the above lake.

I have marked Gravel Point on the map, from its being a well-known resting-place. Its exact position is not to be discerned on so small a chart; but it is near the western angle of Nipigon Bay. Its name refers to the shingle flat constituting it.

Twenty-one miles and a half south-west from Gravel Point, are the Mammelle Hills, giving a name to the district included between this point and the east end of the Great Traverse to the foot of Thunder Hill, from the last island of the clusters about the mouth of Black Bay. The Mammelles, strictly speaking, are two mamillary eminences, about 500 feet high, and close together. They are the southern extremity of a ridge, (everywhere else lower,) coming from the interior of the great promontory dividing Nipigon and Black Bays, and which is probably a peninsula.

The district of the Mammelles is extremely intricate. The main consists of numerous and deep bays, with an interior full of high and very steep hills and narrow valleys. It is beset with islands of all dimensions, advancing several miles into the lake. When of considerable elevation, (for usually they are low,) their summits are flattened, and rise in stair-like ledges. In so confused an assemblage of islands, there are of course several canoe routes; an inner one, through what is called the "Stag's-horn Narrow," possesses scenery of great interest. Close to the outer and shorter route, there is a singular rock, sixteen miles south-west from Gravel Point, named, (like an island in Nipigon Bay,) "La Grange." It is on the south end of a low island, which here swells into a mound of debris 30 or 40 feet high. On this seemingly-artificial eminence a large square mass of rock rises at once perpendicularly about 90 feet, rent at the top into rude bat-

tlements, and marked, along its mural sides, by deep pilasters. It is a conspicuous object resembling a tower in ruins from a great distance in all directions.

I have nothing further to add to the topography of the Mammelles.

Black Bay, contained by the promontory of the Mammelles and the high lands in the rear of Thunder Hill, may be fifteen miles across at its mouth, and is (as I have been informed by Lieutenant Bayfield) 46 miles deep, extremely woody, even to the water's edge, and receives a large river at its bottom. The mouth is guarded by multitudes of woody, and for the most part low, isles. Of their occasional interspaces, the largest is the traverse leading to Thunder-Hill, nearly six miles and a half across; with one or two islets near each end. The high hills at the bottom of Black Bay are visible from the mouth, but a good deal depressed below the horizon. Several islands, apparently large, occupy the centre of the bay.

From the magnificent headland, called Thunder Mountain, (to which we have now arrived,) to the Grand Portage, leading to the lakes of the north, and to the rich plains bordering on the Rocky Mountains, the distance is 57 miles, measuring along the route of the commercial canoes, which always call at Fort William. This interval consists of one very large bay, Thunder Bay, and a deeply-indented coast, principally consisting of shelving rocks and cliffs, and fronted by groupes of islands.

Thunder Bay is of a round form, and has a general diameter of 11 or 12 miles; Thunder Mountain being its eastern angle, and Grand Point the western. Its west side is low and swampy, and mingles very gradually with the hilly ridges of the interior. The bottom is chiefly in bold declivities, with here and there a scarp of vertical fissures. The eastern side is high, and clothed with small pines, birch, and aspen. At its outer extremity, it rises to the height of 1400 feet in Thunder Mountain, as measured by Count Adriani *, and I think, accurately, on comparison with other known heights in the lake.

* Count Adriani, an Italian nobleman, about the year 1800, fitted out a

This mountain is several miles long, and of considerable breadth, except at the point; which is well marked and descends into the lake by three shelves. The west half of its summit is almost tabular; but the eastern half is irregular and hummocky, dipping suddenly in round masses, into a lower but still elevated country. About the middle of its south side, where the height is greatest, an immense cavity, with steep woody acclivities, is scooped out of the body of the mountain. On the south-west, the upper third of the elevation is occupied by precipices, fissured into vertical pilastres, weathered orange red, and advancing occasionally in large buttresses. These precipices are largest on the north-north-west side of this headland; there extending over two-fifths of the whole height, but in other parts they only reach one-third downwards, or less, and are interrupted by coppice. They everywhere (I continue the description downwards) terminate on naked and steep slopes of debris, from 300 to 500 feet in height, encroached on, greatly and irregularly, by underwood, creeping upwards from three woody shelves or terraces, which form the base of the mountain, and are washed by the waters of the lake. They appeared to be broadest at the south-east end, and are there about a mile in breadth. I did not perceive them at all on the side looking on Thunder Bay. What are above termed pilasters, are smooth prolonged slabs, perpendicular, and formed by the disappearance at certain intervals, of vertical slips of rock.

The south face of Thunder Mountain is skirted by islets and reefs. The immediate shore is distributed into sandy beaches, rocky inlets, and straight scarps.

light canoe at Montreal, through the agency of Messrs. Forsyth and Richardson, and circumnavigated Lake Superior. He occupied himself in astronomical observations, and the admeasurement of heights; mingling also freely with the Indians. Mr. Thompson furnished me with the above fact respecting Thunder Mountain. Lord Selkirk has quoted him in a pamphlet on the late disputes in the north-west territories; but I cannot find either this pamphlet or any publication of the Count's, although I have examined most of the Italian, French, and British periodical works on science which have appeared since 1800.

The only isles in Thunder Bay are Hare, Welcome, (or Traverse,) and Sheep Isles. The first is one mile and two-thirds N. 37W. from Thunder Point, and is merely a few low rocks, around which the waves have deposited sand and bowlders. It is in the route to Fort William, and is useful in stress of weather. The Welcome Isles are four and a quarter miles east-south-east from Fort William, three in number, small, tolerably wooded, based on greenstone trap, which in the strait used by canoes passing to the Fort, rises 50 feet high, deeply fissured. Sheep Isle is a small patch of marsh, one mile and three quarters S. 39E. from Fort William.

Thunder Bay may contain several rivers, but I only know of two, the Dog River, called the Kaministiguia, ("the river entering the lake near islands,") by the Indians of Lake Superior, and another smaller, two and a half or three miles on the north-east of the Dog River.

The Dog River issues from a considerable lake of the same name, on the new route to the Lake of the Woods, in long. 84° 40′ and lat. 48° 45′. In the first half of its length, it runs south; and east during the remainder. It has numerous rapids, and some splendid falls, especially those of Du Chien and La Montagne. At its lower end I observed a fertile soil of clay, sand, and vegetable mould. It enters Lake Superior amid extensive morasses by three channels, of which the southern is the longest, and somewhat the broadest, being 1600 yards long, and 100 yards broad. The middle fork is much the smallest, and is obstructed by fallen trees.

Fort William, once the depôt, at which were yearly assembled the wintering partners of the North-west Company of fur-traders, with the proceeds of their commerce with the natives, is placed on the north channel of this river, 800 yards from the lake. It is a large picketted square of dwellings, offices, and stores, all now dilapidating rapidly. It is 403 miles from the Falls of St. Mary to Fort William.

The distance from Fort William to the Grand Portage is 42

miles, as measured on the ice in the winter of 1822-23, by Mr. Ferguson*. Mr. Thompson has made it 44 miles by log; but he followed the curvatures of the shores very closely.

Up to Grand Point from Fort William, the shore is swampy, but there the hills, which, in lofty slopes and scarps, for some way inland, skirt the Kaministiguia, (and perhaps are highest at "Mackay's Mountain," a little above the south fork,) join the lake, and line it, in precipices from 300 to 600 feet high, south-westward, nearly to Pigeon Bay. They have flat pine-clad summits, and are interrupted at intervals by ravines from the rear and by coves of the lake. A slope of ruins, clothed with birch and aspin, creeps up their sides, and now and then extends some hundred yards into the lake.

The shores of two moderately deep bays, east of Pigeon Bay, are frequently also escarped, but being rather low, disclose a steril interior of massive ridges, attaining an elevation of 600 and 900 feet, and affecting a certain parallelism with the coast.

Pigeon Bay is supposed to be the "Long Lake" of French geographers, and to have been intended in the Treaty of 1783, between Great Britain and the United States, as the point of departure from Lake Superior of the boundary line passing to the Lake of the Woods, therein ordered to be designated. This bay is nearly three miles across at its mouth, and rather more than four in depth. Its south side runs nearly east, as a narrow tongue of rock and sandy beach, three and a half miles long, and in one part not more than 200 or 250 yards broad. It ends in Pigeon Point. The north side is nearly twice the above length. It contains two coves, the southern and smaller of which, having the additional shelter of an islet, has been used as winter quarters for a schooner belonging to the North-west Company. Off the south angle of the other cove, (containing the mouth of a rivulet,) there is an islet; and two others, very small, are in the middle of the bay. The scenery of this bay is the same as that of the bays east

* Astronomer to the Boundary Commission under the sixth and seventh articles of the Treaty of Ghent.

of it. The Pigeon River* enters Lake Superior, at the south corner of the contracted bottom of this bay. I do not know its size at the mouth. One mile and a half from the lake, it presents a fall 120 feet high; then dividing a little below, into two channels for a short space.

From Pigeon Point there succeeds, for six miles to Point Chapeau, the east headland of Grand Portage Bay, a rocky coast, tolerably straight, excepting a bay at the west end, a mile and a half broad. The views here are remarkably fine, especially as assisted by the numerous and occasionally lofty islands which chequer the neighbouring waters. The interior is nearly naked; an assemblage of mountain flanks cut through by defiles. By no means the highest of these ridges, that overlooking Point Chapeau, Mr. Thompson found by geometrical admeasurement to be 840 feet high. Point Chapeau is a rocky bluff, about 30 feet high, which rises slowly, in the rear, to the height above-mentioned. It is rather more than two miles from the brook, at the bottom of Grand Portage Bay, around which the commercial establishments of the fur-traders were formerly placed. This bay is two miles and three-quarters wide, and about a mile and a third deep. Its shape is semicircular. It has along its curving bottom an extensive beach of sand, but has ledges of rock and shingle elsewhere. The warehouses, dwellings, stables, and gardens, occupied a flat about three quarters of a mile broad, but not so deep, and backed by high hills.

Near Point Chapeau is Sheep Island, (Isle aux Moutons.) It is several hundred yards in diameter, and is formed of a collection of rocky mounds, skirted on the north by a small alluvial deposit.

Numerous islands occur at irregular distances between Thunder Bay and the Grand Portage. Their size and position are best seen by an inspection of the map; more however should be inserted. They are largest and most frequent along shore, but islets and rocks stretch to Isle Royale. They are rocky, and are

* This river will be more minutely described in a paper on the topography and geology of the chain of streams and lakes leading from the Grand Portage on Lake Superior to the Lake of the Woods.

in hummocks, cliffs, and ledges, partially covered with small timber, seldom exceeding 100 feet in height, and usually much lower. The large broad island called the Patè, situated near the west skirts of Thunder Bay, and two miles and a half from the main, is a prominent feature in this region. In addition to its high ridges, ranging about south-west, and occupying its north-eastern and middle portions, at its west end an immense insulated square mass of rock rises perpendicularly from flat and woody ground, to the height of 1400 feet. It gives name to the island from its shape resembling that of a raised pie. This tower-like eminence may be about half a mile in diameter. It is flat-topped, and its sides are faced by vertical pilasters resting on a talus.

Isle Royale is 45 miles long and nine miles broad in the middle, by admeasurement; but it tapers towards each end. It extends from opposite Pigeon Bay to opposite Thunder Mountain; its distance from both those places not being far short of 15 miles. Although possessing the usual irregularites of coast, the general direction of the island is north-east, the course assumed also by its several ranges of hills, and the narrow islets and reefs which fringe its north-eastern half. I have not been able to perceive in the hilly ranges of the main of Lake Superior any decided general trend.

Isle Royale is lofty, and particularly on the northern side of its west end. I am indebted for my information respecting this island to Mr. Astronomer Ferguson.

I may here remark that the Isles Phillipeaux, placed in all French and English maps, on the outside of Isle Royale, do not exist. In these maps also is laid down, in the supposed situation of Isle Caribou, the island of Poutchartrain, nearly as large as that of Michipicoton. It is a fiction, unless we consider Poutchartrain another name for Isle Caribou, a low, rather woody isle, a mile and a half in diameter, and out of sight of land.

The general direction of the main shore of Lake Superior from the Grand Portage to the River St. Louis, at the Fond du Lac, is WSW$\frac{1}{2}$W. in a slightly concave line, abounding in small curvatures, with here and there a shallow bay, one, two, and rarely

three miles across at the mouth. It is for the most part rocky, but with occasional sandy beaches. Sixty miles from the St. Louis, there is, on the main, a cliff from 350 to 400 feet high, fissured perpendicularly, called (like others previously met with) "La Grange." The interior is every where lofty; and at the distance of 100 miles from the above river, its hills are 600 and 700 feet high. Mr. Thompson has marked on his map 32 rivers and brooks, inclusive of the St. Louis, in the interval of which we now speak. They are mostly chains of cataracts and rapids. In several instances they form groupes of three or four. A river which enters the lake among high rocks, $23\frac{1}{3}$ miles from the St. Louis, is 180 feet broad; another eight miles and three quarters further east, undergoes a descent of 40 feet at its junction with the lake, but it is only 15 yards broad. Twenty-three and a half miles from the St. Louis are three islets; another $38\frac{1}{2}$ miles distant; a fifth 49 miles off in a bay; and a sixth 57 miles from that river. I have gleaned this information from the notes attached to Mr. Thompson's table of courses and distances round the whole lake, which he obligingly allowed me to copy.

Mr. Schoolcraft states that the River St. Louis is 150 yards broad at the mouth, but expands immediately into a sheet of still water, shallow and weedy at the sides, 23 miles long, and a mile in its greatest breadth; in the lower five or six miles. This river rises in several branches from the small lakes in the north, which communicate by portages with the streams falling into the deeper fork of the River La Pluie, the outlet of the lake of that name. I saw at Fort La Pluie, in 1823, Indians, who I was given to understand, had come by this route from near the Fond du Lac Superior to trade with the Hudson's Bay Company.

The name of Fond du Lac, given by the French to the west end of Lake Superior is appropriate. It is a slowly-contracting cul-de-sac, 60 miles long, and from eight to ten miles broad at the bottom. It commences in long. 91°, at the great promontory opposite to the Isles of the Twelve Apostles.

To complete the tour of Lake Superior, I shall now sketch in a few paragraphs the leading features in the geography of its south

shore, deriving all my facts from Messrs. Thompson and Schoolcraft.

Its general direction is about east and west. It is divided by the promontory of Keewawoonan* into two nearly equal parts, the eastern of which is chiefly a concave shore, 176 miles long; (Schoolcraft) the remainder consisting of a large bay at each end of this extensive but gentle curve; that on the west being contained by points Au-baie and Keewawoonan; and that on the east by Points Whitefish and Iroquois. The most remarkable localities are the pictured rocks, which have been repeatedly described; and Grand Isle, abounding, as I am informed by Mr. Thompson, in singular and beautiful scenery. Its position and shape may be best ascertained by consulting the map. The Huron Group, and others near Granite Point, are almost the only isles on this side of Point Keewawoonan. There are 139 rivers and creeks on the whole south shore, but fewer in this, the eastern division, than in the western.

Point Keewawoonan is a rocky promontory, with three principal summits, from 40 to 45 miles long, and from 15 to 17 miles, in its greatest breadth, which is at the Portage. Its length lies north-east, and it tapers almost to a point, at its extremity; a few miles east of which is a small island. Its outline differs considerably from that delineated on former maps; the east side being nearly straight, while the west is a regular and bold curve.

This point is in fact a peninsula, connected to the main land by a portage 2000 yards long, situated on the west side of its lower end or base. The waters giving it this character are, the River Keewawoonan, eight miles long, the narrow lake of the same name 12 miles long, and a brook at its north-west end, six miles in length, and rising on the north. These distances (Mr. Schoolcraft) give a total of 24 miles; but Mr. Thompson's map does not allow so great a length to the two streams, as those stated above.

* I write this word after the manner of Mr. Thompson, whose residence of 27 years among the Indians, acute ear, and good general education, make him excellent authority in the orthography of Indian words.

Mr. Thompson expressed to me his surprise that this peninsula should furnish 25 rivers and brooks, exclusive of that of the lake, three of them being considerable; one near north-east end has a fall 30 feet high.

From Point Keewawoonan, westwards, the shore passes nearly WSW., with a waving outline, to the strongly-marked headland immediately north of Point Cheguimegon, and fronted by the almost unknown cluster of large islands, named after the twelve apostles. Close on the west of this headland, the long island of Montreal ranges south-west. Here the Fond du Lac, already noticed, commences. In this division of the south shore of Lake Superior, the rivers are very numerous; the most remarkable being Ontonagon, (Coppermine River,) Montreal, and Burnt River. Of these, I shall only allude to the second, as being of some magnitude, and leading to Lake Flambeau, placed on the south, in a district of sandy and argillaceous alluvion, loaded with dense woods, and once celebrated for the abundance of its game. Near Lake Superior the river undergoes a fall of 80 feet. It is ascended by the fur-traders for a considerable distance, when a portage through swamp and forest is made of the enormous length of 120 poses, (about 35 miles,) to reach a second stream, by which they arrive at Lake Flambeau. (Mr. Sayer.) This part of the south shore is of moderate height, except where the Porcupine Mountains approach the lake, in longitude 90°. They are estimated by Captain Douglas at 1800 feet in elevation. Major Long lays them down as a continuation of the Oniscconsin Hills.

I proceed to the geology of Lake Superior. I have examined the interval between the Falls of St. Mary and the Grand Portage with all possible care; for it is to be remembered, that I was only a traveller hastening to a more distant point. I landed on the main and islands every five miles, making now and then short excursions from the place of disembarkation. With this advantage, together with being constantly close in shore, (except in crossing bays,) I have been enabled to designate the boundaries of the principal rocks, but sometimes indeed from distant observation

only. The more minute geological remarks on the north shore will be rendered more clear by premising a few general statements.

A red-and-white sandstone, for the most part horizontal, predominates on the south shore, resting in places on granite. It shews itself on the north shore near Pigeon Bay, is in great quantity in the Mammelles and Nipigon Bay, and giving occasional intimations of its existence at Cape Maurepas, and off Gravel River, again floors the lake, from near Point Marmoaze to the Falls of St. Mary; excepting at and about Gros Cap, which consists of the clay porphyry of the Pay Plat, granite, and greenstone, *&c.* Amygdaloid occupies a very large tract in the north, stretching from Cape Verd to the Grand Portage (at least), profusely intermingled with argillaceous and other porphyries, sienite, trappose greenstone, sandstone, and conglomerates. Points Gargantua and Marmoaze, with their neighbourhood, are of amygdaloid. It is traced, in small quantity, to Gros Cap, by Major Delafield, and constitutes moreover the great promontory of Keewawoonna, associated with other forms of hornblende rocks. At Points Gargantua and Marmoaze only could I detect a stratification in any of these rocks, but the two last enumerated above. The amygdaloid there runs N. and NNE.*, with a westerly dip.

Trappose-greenstone is the prevailing rock from Thunder Mountain westward, and gives rise to the pilastered precipices in the vicinity of Fort William. It passes northward into the interior, and ceases at the west end of Gun-flint Lake, in lon. 90° 45′, on the old route to the Lake of the Woods, nearly opposite to the entrance of Two Island River into Lake Superior. Mr. Thompson informs me that, mixed with sienite, this rock is continued westward, nearly, if not quite, to the River St. Louis. The portion of the northern and eastern shore not yet noticed, in-

* The following are the results of all the observations by Mr. Thompson on magnetic variation in Lake Superior, with which I am acquainted, but I hope to be furnished with more soon, *viz.*;—at the River St. Louis, 5°E.; 31 miles west of Grand Portage, 2°E.; Fort William, 6°6½E.; Thunder Point, 1°E. Point Marmoaze, 6°E.; about Nipigon Bay the compass is much disturbed.

cluded between Cape Verd and Point Marmoaze, is the seat of older formations. These are sienite, chiefly abounding about Peek Island; and greenstone, more or less chloritic, interstratified with conglomerates, and alternating five times with vast beds of granite, which some might pronounce a sienite from the abundance of its hornblende. The stratification of the greenstone is usually very indistinct, but often again it is clearly marked. The direction is always east or east by north, with a northern or perpendicular dip, except at the Dog River, where the former decidedly varies from WNW. to north, with a perpendicular or easterly dip.

It is important to note the great quantity of the older shell limestone strewn in rolled masses on the beaches from Point Marmoaze to Grand Portage. It has not yet been seen *in situ*. From the crags of Michipicoton to the latter place it forms a considerable item in the amount of the debris. Its organic remains are trilobites, orthoceratites, encrinites, productæ, madrepores, terebratulæ, *&c.* I met with a large loose mass of pitchstone porphyry at the west angle of Michipicoton Bay, the opposite angle being trappose.

I have now to describe with some minuteness, the nature, contents, and connexion of the rocks above enumerated, as they occur in succession on the north shore; and commencing from Gros Cap. This concluded, I shall give a rapid view of the principal points in the geology of the south shore.

[To be continued.]

ART. II. *Of the Effects of the Induced Magnetism of an Iron Shell, on the Rates of Chronometers. By* George Harvey, Esq. F.R.S.E. M.G.S., *&c.*

[Communicated by the Author.]

THE differences known to exist between the sea and land-rates of chronometers, have led to many interesting inquiries respecting the influence of magnetism, on these delicate and valuable machines. The investigation has been contemplated generally under two points of view; first, as regards the effects of permanent

magnetism on the rates of time-keepers; and secondly, as respects the influence of that temporary degree of magnetism which is communicated to iron generally, by induction from the earth. Experiments on the former of these divisions have, however, been by far the most numerous, in consequence, it may be presumed, of the powerful effects it is capable of producing. But it may be questioned, whether an inquiry into the alterations of rate produced by the action of induced magnetism, be not in reality, the most useful and important of the two; and, though presenting results of a less striking and remarkable character, deserves more particularly to be investigated, on account of the greater analogy it bears to the actual circumstances of a chronometer on shipboard.

The magnetic influence developed by the iron of a ship, or what is commonly termed its local attraction, owes its origin to induction from the earth. Its character is varied and uncertain in some situations, unfolding its powers with singular energy and force; whilst in others it either coincides in quantity with the ordinary terrestrial intensity, or from the opposite and varied directions in which the attractive forces act, exhibits an influence very much below it; agreeing in the whole system of its changes with the alterations known to take place in the magnetic intensity of masses of iron, when made to assume different positions, with relation to the magnetic meridian.

With such a perfect coincidence therefore between the local attraction of a ship, and the induced magnetism of iron, it seems difficult to account for the conclusions obtained by Mr. Fisher* and Mr. Barlow †, in their ingenious and valuable inquiries respecting rates of chronometers; the experiments of the former leading us to infer, that the effects of iron on time-keepers is in general to occasion an *acceleration* of their daily rates, and of the latter, a *retardation.*

Reasoning *à priori*, from our knowledge of the fact, that *permanent* magnetism sometimes accelerates, and at other times retards the rate of a chronometer according to the direction in

* Philosophical Transactions for 1820.

† Philosophical Transactions for 1821.

which the attractive force acts, with relation to the balance, it would seem reasonable to infer, that the induced magnetism of a simple iron mass, ought to produce effects of an analogous kind; since the nature of the force is the same, and varies only in degree.

With this view of the subject, I was induced, in the early part of the year 1822, to undertake a course of experiments, in order to determine the influence of unmagnetized iron on several good chronometers; and that branch of the inquiry which relates to the effects of a thirteen-inch iron shell, I now submit to the readers of the Journal of Science*.

The concentric circles NE. SW., Figs. 1, 2, *&c.*, Plate II, represent a horizontal section of the iron sphere passing through its centre, the diameter NS., being in the magnetic meridian. The smaller circles A, B, C, D, E, are horizontal sections of the chronometers, in the situations in which they were respectively placed round the sphere; those situated either above or below the horizontal plane, being orthographically projected on it. The positions of the balances and main springs of the time-keepers, are represented by the lesser circles marked B and S; and by which the positions of those important parts of each chronometer, with respect to the attracting mass, may be clearly seen. Figs. 5 and 11 represent vertical sections passing through the centre of the iron shell, and the centres of the chronometers A, B, and F, A, in the direction of the magnetic meridian; the centres of their faces being also in the plane E, Q, the magnetic equator of the sphere. In like manner, Figs. 6 and 12 exhibit sections at right angles to the former, passing through the centre of the sphere, and the centres of the time-keepers E, D, C, and C, B, D, E; and disclosing the relative positions of their balances and springs†. So

* In two other papers, I propose to treat of the influence of re-magnetized iron plates and iron bars, on the rates of chronometers.

† It was found impossible to introduce all the positions of the balances and springs of the different chronometers, represented in the different horizontal sections, *in the vertical sections*, without several additional figures. Their positions represented in the last-mentioned sections do not refer to either of the horizontal sections in particular, but are merely introduced for illustrating their situations vertically.

many horizontal sections are given, for the purpose of illustrating the alterations produced in the positions of the balances and main springs, in consequence of the time-keepers having been turned round their vertical axes during the successive experiments, to discover the changes of rate resulting from the different positions of those parts of the machine, with respect to the ball and the magnetic meridian. The constant distances of the vertical axes of the chronometers from the centre of the sphere, together with the elevations or depressions of the centres of their faces, above the same point, are entered in the respective tables. The time-keepers employed were those of the box kind.

The first experiment was with the chronometer A, placed to the north of the shell, having the centre of its balance in the magnetic meridian of the iron mass, and the hour of XII directed to the north. The position of the time-keeper was also so regulated, that the centre of its face might be in the plane of the magnetic equator of the ball. The result of this application was, an increase of the rate of the chronometer from + 9″.7 to + 10″.7, the rate in this and all the subsequent experiments, being determined by the mean of four days' observation. By turning the time-keeper a quadrant, so as to make it occupy the position denoted by A, Fig. 2, with XII pointing to the east, and the centre of the balance, in a situation at right angles to its former position, the rate was augmented to + 11″.3; and, by again turning it a quadrant, so as to bring the balance again into the magnetic meridian of the ball, as in Fig. 3, the daily variation became + 12″.6; and by again moving it through another similar space, into the position denoted by A, Fig. 4, the rate declined to + 11″.4. When detached from the iron mass, the rate was found to be + 12″.8, the time-keeper having increased its rate + 3″.1, in consequence of its application to the shell. Hence the influence of the ball occasioned an *unequal increase of rate in the chronometer in all its positions; the mean of the four being + 11″.6, which is an increment to its detached rate of 1″.7. It will also be perceived, that the greatest increment the time-keeper received, was produced when the balance was farthest removed from the attracting mass; and the least alteration of rate, when nearest to it; and that the positions* (2, 4) *at right angles to*

the former, and when the balance was at its mean distance from the globe, the rates were very nearly equal.

The preceding results are entered for the sake of a convenient reference, in the following Table, together with the positions of the time-keeper, with respect to the geometrical centre of the attracting mass:

Chronometer A in the Magnetic Meridian of the Iron Shell, and to the North of it.							
Distance of the Vertical Axis of Chronometer, from Centre of Shell.	Elevation of the Centre of the Face, above the Centre of the Shell.	Detached Rate.	Rate in Fig. 1.	Rate in Fig. 2.	Rate in Fig. 3.	Rate in Fig. 4.	Detached Rate.
11.4 Inches.	4 Inches.	+9″.7	+10″.7	+11″.3	+12″.6	+11″.7	+12″.8

The second chronometer B, was placed to the south of the ball, with the centre of its balance in the magnetic meridian of the ferruginous mass, and XII directed to the north, as represented in B, Fig. 1. This application of the time-keeper produced no alteration of rate; but on turning it a quadrant, so as to make the magnetic meridian of the ball form nearly a tangent to the rim of the balance, as in B, Fig. 2, the rate was changed from −7″.6 to −6″.9; the time-keeper having gained 0″.7 by the change. In the next position, denoted by B, Fig. 3, the balance being again in the magnetic meridian of the ball, and at its least distance from it, the daily decrement was augmented to −7″.2, being only 0″.4 less than the rate, when the balance was before placed in the meridian, and at its greatest distance from the ball. No observations were made with the machine, by turning it through a fourth quadrant. It appears, therefore, that *the time-keeper B underwent no alteration of rate, by placing the centre of its balance in the magnetic meridian, and at its greatest distance from the attracting body; and only a minute increment, when at its least distance; nor was the change in the rate of the chronometer much greater when a line drawn from the middle of the balance was at right angles to the meridian of the ball. This chronometer, therefore, from its having probably a balance nearly free from the magnetic influence, underwent but little alteration of rate, by its application to the iron mass.* The preceding results are arranged in the next Table:

Chronometer B in the Magnetic Meridian of the Iron Shell, and to the South of it.						
Distance of the Vertical Axis of Chronometer, from Centre of Shell.	Depression of the Centre of the Face, below the Centre of the Shell.	Detached Rate.	Rate in Fig. 1.	Rate in Fig. 2.	Rate in Figs. 3 or 4.	Detached Rate.
9.9 Inches.	2.5 Inches.	$-7''.6$	$-7''.6$	$-6''.9$	$-7''.2$	$-7''.1$

The next chronometer C, was placed on the eastern side of the iron sphere, with the middle of its face in a vertical plane passing through the centre of the ball, and at right angles to the magnetic meridian; and moreover, so elevated, that a line, joining the centre of the face and ball, might intersect the magnetic parallel of 45° N, as represented in C, Fig. 6. The detached rate of this time keeper was $-7''.2$; but when the centre of the balance was brought into the East and West plane, so as to be at its least distance from the attracting mass, as denoted by C, Fig. 1, the rate altered to $-6''.8$; and on turning the chronometer through a complete semicircle, into the position of C, Fig. 2, thereby bringing the middle of the balance again into the last-mentioned plane at its greatest distance from the iron ball, the losing rate increased to $-7''5$. By again turning the time-keeper through a quadrant, in order to bring the line joining the centres of the chronometer and balance, into the magnetic meridian, as C, Fig. 3, the daily aberration became $-6''.5$; and, on afterwards turning it through an entire semicircle, into the position denoted by C, Fig. 4, the centre of the balance being still in the magnetic meridian, the daily rate of the time-keeper changed to $-8''.8$; and, by detaching it altogether from the influence of the iron, the daily aberration was found to be $-8''.4$. *This chronometer, therefore, gained in the positions corresponding to figures* 1 *and* 3, *but lost in those represented by* 2 *and* 4.

Chronometer C in a Vertical Plane passing through the Centre of the Iron Shell, at right Angles to the Magnetic Meridian, and to the East of it.							
Distance of the Vertical Axis of the Chronometer, from Centre of Shell.	Elevation of the Centre of the Face, above the Centre of the Shell.	Detached Rate.	Rate in Fig. 1.	Rate in Fig. 2.	Rate in Fig. 3.	Rate in Fig. 4.	Detached Rate.
7 Inches.	8.5 Inches.	$-7''.2$	$-6''.8$	$-7''.5$	$-6''.5$	$-8''.8$	$-8''.4$

The fourth chronometer employed was D, in a similar situation to the preceding, on the western side of the ball, as D, Fig. 1, or D, Fig. 6. The detached rate of the machine was + 5″.0, and when it occupied the position of D, Fig. 1, the mean of five days' observations, gave a rate of +4″.9; the iron mass having scarcely produced any effect. By turning the time-keeper, however, a quadrant, so as to bring the centre of the balance into the magnetic meridian, and the east and west plane touching its circumference as D, Fig. 2, the rate augmented to +6″.3; and, by again bringing the centre of the balance into the last-mentioned plane, as represented in D, Fig. 3, a farther acceleration took place, the rate being found to be +7″.8; but on turning it through another arc of ninety degrees, corresponding to the situation D, Fig. 4, the daily alteration declined to +7″.0; and, on finally detaching the chronometer from the ferruginous mass, its rate became +6″.5; having increased its former detached rate +1″.5, in consequence of the experiment. *Hence it appears that the application of this chronometer to the attracting mass scarcely produced any effect in the position denoted by Fig. 1; but an acceleration of its rate took place in the situations represented by Figs. 2, 3, and 4; and by removing the time-keeper from the magnetic influence, the rate declined, though not to the same degree.*

Chronometer D in a Vertical Plane passing through the Centre of the Iron Shell, at right Angles to the Magnetic Meridian, and to the West of it.							
Distance of the Vertical Axis of the Chronometer, from Centre of Shell.	Elevation of the Centre of the Face, above the Centre of the Shell.	Detached Rate.	Rate in Fig. 1.	Rate in Fig. 2.	Rate in Fig. 3.	Rate in Fig. 4.	Detached Rate.
8 Inches.	9.5 Inches.	+5″.0	+4″.9	+6″.3	+7″.8	+7″.0	+6″.5

The fifth chronometer E, was also placed on the western side of the ball, as in E, Fig. 1, having the middle of its face in a vertical plane passing through the centre of the sphere at right angles to the magnetic meridian, and also in a horizontal plane, passing through the same point. In this situation of the time-keeper, the line joining the centre of its balance and the centre of the chrono-

meter was in the magnetic meridian, the rate having changed from —3″.5, the daily aberration in its detached state, to —3″.0. On turning the time-keeper, however, a quadrant, that it might occupy the situation of E, Fig. 2, the rate became—3″.3; and on giving to it the position of E, Fig. 3, a decrement of — 1″.9 resulted, the rate amounting in this situation to — 5″.2; but on moving the chronometer through another quadrant, that the balance might occupy the position of E, Fig. 4, an increment of + 2″.3 was produced, the rate being — 2″.9. When detached, the rate of the time-keeper was found to be — 2″.2. Hence it appears that *the application of this time-keeper to the iron mass, occasioned both an acceleration and a retardation of rate; the greatest increment corresponding to the position of E, Fig.* 4, *and the greatest decrement, to that of E, Fig.* 3. This completed the first course of experiments.

Chronometer E in a Vertical Plane passing through the Centre of the Iron Shell, at right Angles to the Magnetic Meridian, and to the West of it.							
Distance of the Vertical Axis of the Chronometer, from Centre of Shell.	Elevation of the Centre of the Face, above the Centre of the Shell.	Detached Rate.	Rate in Fig. 1.	Rate in Fig. 2.	Rate in Fig. 3.	Rate in Fig. 4.	Detached Rate.
11.5 Inches.	0 Inches.	—3″.5	—3″.0	—3″.3	—5″.2	—2″.9	—2″.2

A second course of experiments was now undertaken with the same chronometers placed in other situations round the Iron Shell, and also with the addition of the time-keeper F.

For this purpose, the chronometer A, instead of being placed to the north of the ball, as in the former course of experiments, was now placed to the South, as in A, Fig. 7, with the centre of its balance in the magnetic meridian of the attracting mass. The detached rate of the time-keeper was +12″.8, it having retained the impulse communicated to it in the former set of experiments; and, the result first presented by it in the new position was +12″.4, the rate having undergone a trifling declension; but, on moving the chronometer into the situation denoted by A, Fig. 8, the line joining the centres of the balance and chronometer being in this

situation at right angles to the meridian of the ball, the rate declined to + 10″.9, and which rate it nearly preserved, in the position of A, Fig. 9, the rate in this situation being + 10″.8; but, on turning it into the position of A, Fig. 10, the daily variation augmented to + 12″.2; and, on finally detaching the chronometer, the rate was found to be + 9″.9, agreeing within 0″.2 of its detached rate, prior to the first experiment.

Three remarkable circumstances were disclosed by this experiment. In the first place, a considerable *declension* in the rate took place, by removing the chronometer from the position in which its balance was nearest to the attracting mass, as A, Fig. 7, into the situation denoted by A, Fig. 8, where the line joining the centres of the balance and chronometer, was at right angles to the meridian of the balance; and secondly, an *acceleration* equally sudden was produced, by removing the time-keeper from the position in which the balance was farthest from the iron ball, as A, Fig. 9, into the position of A, Fig. 10, where the line connecting the centres of the time-keeper and balance, was again at right angles to the meridian; and thirdly, that the acceleration communicated to the detached rate, in consequence of the first application of the time-keeper to the action of the ferruginous, was entirely removed by the effect produced during the second set of experiments.

Chronometer A in the Magnetic Meridian of the Iron Shell, and to the South of it:							
Distance of the Vertical Axis of the Chronometer, from Centre of Shell.	Depression of the Centre of the Face, below the Centre of the Shell.	Detached Rate.	Rate in Fig. 7.	Rate in Fig. 8.	Rate in Fig. 9.	Rate in Fig. 10.	Detached Rate.
8.9 Inches.	2.5 Inches.	+12″.8	+12″.4	+10″.9	+10″.8	+12″.2	+ 9″.9

In the next place, the chronometer B, which in the first set of experiments, occupied a situation to the south of the ball, was now placed immediately above its zenith, as in B, Fig. 7, 11, or 12, with XII pointing to the West; and which occasioned its rate to alter from −7″.1 to −6″.6; but, on turning it a quadrant, so as to bring XII to the South, the daily variation became − 7″.0, and which was altered to − 7″.2, when XII was directed to the East.

On moving it through another quadrant, thereby presenting XII to the North, the daily aberration became – 6″.0, having gained 1″.2 by the last movement. Lastly, by detaching the time-keeper from the iron mass, the rate became – 6″.6. *This chronometer, therefore, both gained and lost in its different positions with respect to the iron mass;—losing by its change of position from Fig.* 7 *to Fig.* 8; *preserving nearly a stationary rate from the last-mentioned position, to Fig.* 9; *and gaining by its removal from Fig.* 9 *to Fig.* 10. *The first application also of the chronometer to the attracting mass, occasioned it to gain, and its removal from it, to lose.*

Chronometer B over the Zenith of the Iron Shell.							
Distance of the Vertical Axis of the Chronometer, from Centre of Shell.	Elevation of the Centre of the Face, above the Centre of the Ball.	Detached Rate.	Rate in Fig. 7.	Rate in Fig. 8.	Rate in Fig. 9.	Rate in Fig. 10.	Detached Rate.
0 Inch.	10.5 Inches.	– 7″.1	– 6″.6	– 7″.0	– 7″.2	– 6″.0	– 6″.6

The third chronometer C, which formerly occupied a position to the East of the ball, over the magnetic parallel of 45° N., was now placed to the West of it, with the centre of its face in a horizontal plane passing through the centre of the globe, and also in a vertical plane passing through the same point, and at right angles to the magnetic meridian. The detached rate was – 8″.4, and which only underwent a minute change to – 8″.2, by placing the machine as in C, Fig. 7, with its balance nearest the ball; but, on turning the chronometer a quadrant, in order that it might occupy the situation C, Fig. 8, the rate declined a second, amounting to – 9″.2; and a still more considerable declension was produced, by causing the centre of the balance to be placed in the magnetic meridian of the attracting mass, and at the same time at its greatest distance from it, as in Fig. 9, the rate amounting in this position to – 11″.4; but on turning the time-keeper through another quadrant, in order for it to occupy the position of C, Fig. 10, a very great acceleration took place, the rate amounting to – 6″.5. By finally detaching the chronometer from the attractive influence, the rate returned to – 11″.1, being a greater losing rate than originally displayed by the machine, before its applica-

tion to the iron mass. *This chronometer, therefore, both gained and lost, as was also determined in the first course of experiments.*

Chronometer C in a Vertical Plane passing through the Centre of the Iron Shell, at right Angles to the Magnetic Meridian, and to the West of it.

Distance of the Vertical Axis of the Chronometer, from Centre of Shell.	Elevation of the Centre of the Face, above the Centre of the Ball.	Detached Rate.	Rate in Fig. 7.	Rate in Fig. 8.	Rate in Fig. 9.	Rate in Fig. 10.	Detached Rate.
9.5 Inches.	0 Inches.	$-8''.4$	$-8''.2$	$-9''.2$	$-11''.4$	$-6''.5$	$-11''.1$

The fourth chronometer D, was placed to the east of the ball, in a vertical plane passing through its centre, and with the plane of the balance in the horizontal plane, supposed to pass through the same point, as represented in D, Figs. 7 and 12. In the former experiment this time-keeper was situated to the west of the ball, in the same vertical plane, but elevated so as to be over the magnetic parallel of 45° North. The first application of the chronometer to the action of the ferruginous mass, communicated an *increment* to its rate, from $+ 6''.5$ to $+ 7''.3$, the line joining the centres of the time-keeper and balance, being in a plane parallel to the magnetic meridian of the globe. By turning the chronometer however, through a quadrant, so as to bring the before-mentioned line into the vertical plane, passing through the centre of the ball, and at right angles to the magnetic meridian, as in D, Fig. 8, the daily variation underwent a *decrement*, it being $+6''.7$; and on turning the machine into the position denoted by D, Fig. 9, where the line connecting the centres of the time-keeper and balance was again parallel to the meridian of the ball, a farther declension was found in the rate, it amounting to $+ 5''.1$; but, on bringing the time-keeper into the situation represented by D, Fig. 10, the rate again recovered itself, it amounting to $+ 7''.1$; and, on removing the time-keeper from the effect of the attractive influence, the rate again declined to $+ 5''.7$. *Hence it appears, that the action of the magnetic power on this chronometer, was to occasion an increase of rate, in all its situations excepting one, where a declension took place; and that the entire suspension of the attracting influence occasioned also the rate to diminish.*

Chronometer D in a Vertical Plane passing through the Centre of the Iron Shell, at right Angles to the Magnetic Meridian, and to the East of it.							
Distance of the Vertical Axis of the Chronometer, from Centre of Shell.	Elevation of the Centre of the Face, above the Centre of the Shell.	Detached Rate.	Rate in Fig. 7.	Rate in Fig. 8.	Rate in Fig. 9.	Rate in Fig. 10.	Detached Rate.
10.2 Inches.	2.5 Inches.	$+6''.5$	$+7''.3$	$+6''.7$	$+5''.1$	$+7''.1$	$+5''.7$

The chronometer E, was, in this second set of experiments, placed below the nadir of the ball, the crystal of the time-keeper just touching it; and the machine was so moved, as to make the positions of its balance correspond to those of the chronometer B, which at the same time occupied a situation in the same vertical line, or over the zenith of the shell. The detached rate of the machine E was $-2''.2$, and which with XII to the West, became $-0''.8$, the same rate being also preserved, when the last-mentioned hour was brought to the South; but on turning the chronometer so as to present XII to the East, the rate became $-3''.2$; the decrement being considerable, in consequence of the last change. This rate, however, was converted into $-2''.0$, by allowing XII to be directed to the North; and, by finally detaching the time-keeper from the action of the iron mass, it farther changed to $-1''.1$. *This chronometer, therefore, gained by its first application to the Iron Shell, and lost when entirely removed from its influence. In two of its positions, the rate was observed to be exactly constant; in a third, the influence of the ball occasioned it to lose, and in a fourth caused it to gain.*

Chronometer E below the Nadir of the Iron Shell.							
Distance of the Vertical Axis of the Chronometer, from Centre of Shell.	Depression of the Centre of the Face, below the Centre of the Shell.	Detached Rate.	Rate in Fig. 7.	Rate in Fig. 8.	Rate in Fig. 9.	Rate in Fig. 10.	Detached Rate.
0 Inch.	6.5 Inches.	$-2''.2$	$-0''.8$	$-0''.8$	$-3''.2$	$-2''.0$	$-1''.1$

Lastly, the chronometer F, which was not employed in the first course of experiments, was now placed to the north of the ball, with the extension of the magnetic meridian of the globe, passing

through the centre of the time-keeper. The detached rate of the machine was + 2″.0, but which was immediately converted into + 3″.4, by its application to the ferruginous mass, in the position denoted by F, Fig. 7, the balance being in this situation at its least distance from the ball. By turning the time-keeper, however, a quadrant, to bring it into the position of F, Fig. 8, this rate declined to + 2″.5; and, by again moving it through a quadrant, to cause it to assume the position of F, Fig. 9, the daily variation remained nearly constant; but, on turning it through another quadrantal arc, the rate increased to + 3″.3; and on finally removing the machine from the influence of the iron mass, the daily change was found to be + 3″.0. *This chronometer, therefore, gained in consequence of the magnetic action of the Iron Shell, and lost when that power was removed from it; and in the different situations assumed by its balance with respect to the magnetic meridian, it sometimes gained, and at other times lost.*

Chronometer F in a Vertical Plane passing through the Centre of the Iron Shell, at right Angles to the Magnetic Meridian, and to the North of it.

Distance of the Vertical Axis of the Chronometer, from Centre of Shell.	Elevation of the Centre of the Face, above the Centre of the Shell.	Detached Rate.	Rate in Fig. 7.	Rate in Fig. 8.	Rate in Fig. 9.	Rate in Fig. 10.	Detached Rate.
9.8 Inches.	4.5 Inches.	+2″.0	+3″.4	+2″.5	+2″.4	+3″.3	+3″.0

From the preceding experiments it may be therefore inferred, that the rates of chronometers are affected by the induced magnetism of iron, and that its effects are of a variable and uncertain character; in some cases developing its energies with considerable force, and in others, producing but feeble and unimportant effects; imparting an acceleration in some positions, and a retardation in others;—influencing different chronometers in different degrees, and according to opposite laws; in some producing augmentations of rate, and in others, with the attracting force operating under the same conditions, as to direction and power, disclosing results precisely the reverse. Of these variable effects, as in the case of what is commonly denominated permanent magnetism,

part may be attributed to the uncertain intensity of the agent producing the aberrations, and part to the imperfect isochronism of the time-keepers employed*;—the former producing necessarily on the same chronometer variable effects, according to the different degrees in which its energy is displayed, and to the different positions assumed by the balance;—and the latter, occasioning in different chronometers, by the operation of the *same* cause, alterations of rate, from less to greater, and from greater to less.

Plymouth, May 25th, 1824.

Art. III. *An Account of the Native Oil of Laurel.* By Dr. Hancock, *of Demerary.*

Essequebo, January 18, 1824.

Sir,

Aware of the interest you take in the progress of useful discovery, and of your readiness to devote your columns to its advancement, I take the liberty of communicating, for insertion in your respectable Journal, a few observations on a very extraordinary vegetable production, the knowledge of which has hitherto been almost exclusively confined to the natives of Spanish Guiana. This substance which has been very injudiciously termed *Azeyte de Sassafras*, an appellation which tends to confound it with the essential oil, yielded by the *Laurus Sassafras*, of the Northern Continent of America, affords, so far as my knowledge extends, an extraordinary and solitary instance of the production of a perfectly volatile liquid, without the aid of art. Substituting for the appellation to which I have objected, the provisional name "*Native Oil of Laurel*," I shall describe the method of procuring it, and enumerate its principal chemical and medicinal properties, so far as they have been investigated and examined.

The *Native Oil* is yielded by a tree of considerable magnitude;

* See an Essay in the 34th Number of this Journal, "*On the Alterations of Rate produced in different Chronometers, by the Influence of Magnetism.*"

its wood is aromatic, compact in its texture, and of a brownish colour, and its roots abound with essential oil.

This tree, which is found in the vast forests that cover the flat and fertile regions between the Oroonoko and the Parime, has from an analogy already alluded to, been supposed to belong to the natural order, *Laurineæ:* and though Humboldt and Bonpland do not seem to have been acquainted with its singular and important produce, its botanical characters may very possibly have been described in their *Plantes Equinoxiales*, under the *Genera Oeotea*, *Pereea*, or *Litsea*. This question I am, however, unable to solve, as I have never seen the parts of fructification.

The *Native Oil of Laurel* is procured by striking with an axe the proper vessel, in the internal layers of the bark, while a calabash is held to receive the fluid. So obscure, however, are the indications of these reservoirs, that the Indians (with perhaps a little of their usual exaggeration) assert, that a person unacquainted with the art may hew down a hundred trees, without collecting a drop of the precious fluid. In many of its properties, the *Native Oil* resembles the essential oil obtained by distillation and other artificial processes; it is, however, more volatile, and highly rectified, than any of them; its specific gravity hardly exceeding that of alcohol. When pure, it is colourless and transparent: its taste is warm and pungent; its odour aromatic, and closely allied to that of the oily and resinous juice of the *Coniferæ* *. It is volatile, and evaporates without residuum, at the atmospheric temperature †. It is inflammable, burning entirely away, and except when mixed with alcohol, gives out in its combustion a dense smoke. Neither the alkalies nor acids seem to exert any sensible action upon the *Native Oil*. Upon dropping into it sulphuric acid, the latter assumes a momentary brownish tinge, but soon regains its transparency, remaining immiscible at the bottom of the vessel. The *Oil of Laurel* dissolves camphor, caoutchouc, wax, and resins; and readily combines with the volatile and fixed oils. It is insoluble

* So striking is this resemblance, that a friend, to whose inspection I submitted the Oil, pronounced it, rather hastily, to be *Spirits of Turpentine*.

† 75°—83° Fah.

in water, soluble in alcohol, and in ether. Though the specific gravity of the oil exceeds that of ether, yet the compound formed, by combining them, in the proportion of one part of the former to two of the latter, floats upon the surface of pure ether, and may therefore be the lightest of all known liquids *.

With respect to the medicinal properties of the *Native Oil*, it bears, when externally applied, the character of a powerful discutient: and appears, when exhibited internally, to be diaphoretic, diuretic, and resolvent; by many it is believed to be analeptic, alterative, anodyne; and to promote the exfoliation of carious bones.

Without listening to the extravagant reports of the Indians, who exalt it into a Panacea, we must admit that its efficacy has been demonstrated in cases of rheumatism, swellings of the joints, cold tumours, pains in the limbs, and in various disorders supposed to originate in a vitiated state of the blood (mala sangre.) In all these cases it is exhibited in doses of twenty to forty drops, on sugar twice a-day; accompanied by frequent and long-continued friction of the parts affected with the oil, while the body is kept moderately warm, and a free use of diluting drinks prescribed to the patient. The same practice is said to have been attended with the happiest effect in paralytic disorders; for this I cannot vouch, but have found it a valuable remedy in cases of nervous and rheumatic headache, sprains, and bruises. A decoction of the root has been employed as an alterative, in various chronic complaints, and with much success.

I am fully aware of the re-action that often results from over-excited and disappointed expectations, and of the discredit into which a new remedy frequently falls in consequence of the unmerited encomiums which those who bring it into notice have injudiciously bestowed upon its virtues.

Quidquid excessit modum,
Pendet instabili loco.

However slight the credibility we may feel inclined to attach to

* A mistake probably: not true of a specimen sent to this country. Ed.

the evidence of the Indians, upon which our knowledge of the medicinal properties of the *Native Oil* almost entirely reposes, the information derived from experience surely claims that attention, and justly challenges that examination, which we should not hesitate to bestow on the speculations of the mere theorist. Let inquiries be instituted, and experiments be made by those who, by situation and scientific attainments, are qualified for the task. By these investigations, it may not only be ascertained what degree of confidence ought to be reposed in the unqualified encomiums which the Indians lavish upon this anomalous production, but properties unknown to them may be discovered, and its history, which they have been accused (perhaps unjustly) of involving in obscurity, be satisfactorily elucidated. To the chemist and vegetable physiologist, in particular, the *Native Oil of Laurel*, elaborated by the unassisted hand of Nature, in a state of purity, which the operose processes of art may equal, but cannot surpass, presents an interesting subject of inquiry, and a wide field of speculation.

Art. IV. *On the Use of the Pocket Box-Sextant to Travellers*, &c.

It has long been a matter of regret and astonishment to the writer of the following pages, that in this age of travelling, when the press teems with books of travels and voyages, there should be so few persons who direct their attention to the following points, *viz.*, the latitude and longitude of remote places, the height of their hills and mountains, and many other objects; the knowledge of which would be so useful in forming comparisons between the climate, and numerous particulars relating to other countries with our own.

Conceiving that many travellers, and especially military men, who frequently possess the proper instruments, are not aware of their powers; and, that the idea of their insufficiency alone prevents them from applying these instruments in such determinations; many experiments have been made with a view to ascertain

them: and it can now confidently be affirmed, that a careful application of apparently slender means, will produce very close approximations, and highly valuable when made in places where it is very unlikely that men of great scientific acquirements, accompanied by costly instruments, may ever arrive. Many a military man and traveller may unexpectedly find themselves in the course of their journeys near ruins where no one has travelled before, or at least no record appears to that effect: this has happened to those who have come overland from India to Europe: or, they may reach a place well described by others, but who have not given its geographical situation; but which is, in many cases, so easily obtained, that we can only attribute the omission to some cause like that before suggested. Now it is hoped that the following experiments, carefully made for the purpose, will arrest the attention of those who seek information and knowledge in foreign countries. It would be of use if they would merely register the observations they may make, and leave the calculation of them to other persons on their return; in that case all that is required is a faithful register, distinctly kept, of such observations, with temperature, and such various particulars as may be collected, according to the instruments possessed by the person.

The amusement a small set of instruments will often afford to a person in a foreign country is considerable: his determinations will be satisfactory to himself, they will corroborate or disprove those of others, and leave less to mere guess than is too often the case. How many various accounts have we seen of the breadth of the Hellespont, and with how little trouble might the matter be settled, by measuring or pacing a base, and taking a few angles with the instrument shortly to be mentioned. How many different heights have been assigned to the Pillar of Pompey, or the Pyramids of Egypt, and many other similar objects, and yet the point could be settled in half an hour at most, by using an instrument so small and light, that whoever visits such places, or enters a magnificent temple or other building, should never be without it; as he may assure himself of the height of its columns, *&c.*, in a few minutes, within a few inches of the truth, and with scarcely

any trouble. I shall now subjoin a few observations made with the pocket-sextant, to shew how admirably it is adapted to the variety of purposes to which a traveller may wish to apply it.

Upon this very small and consequently portable instrument, a much greater reliance may be placed than at first sight appears probable; or than many persons who have not tried its powers would be willing to believe.

Its construction secures it from injury, the adjustments of the mirrors being contained in a small box, as also the rackwork by which the index is moved; so that nothing remains upon the upper plate but the divided limb, the milled head of the rackwork, and a lens to read the divisions.

The same exterior box which preserves this work upon the upper plate from injury when not in use, serves the purpose of a handle when used.

Further description is unnecessary, as it is to be seen in the windows of most opticians, who do not make it a very expensive instrument.

When it is considered that a traveller may have much use for an angular instrument, and that one varying from $2\frac{1}{2}$ to 5 guineas in price is to be had, possessing great accuracy, which he can carry without incumbrance in a waistcoat-pocket, so that he needs scarcely ever be without it, particularly in situations where angular operations are likely to be necessary; it is presumed that a few observations upon its utility will need no apology.

It has been proved by experiment, that horizontal distances exceeding 18,000 or 20,000 feet can be ascertained by it within 2 or 3 feet of the result given by more expensive instruments; but in this case great care must be taken, and the distances calculated, whereas in common cases construction of the triangles is generally considered sufficiently correct. The base was 5786 feet in length, and the ultimate lengths deduced from it through several triangles, were at a distance of about four miles from the base. Now we may remark, that when two objects are in a plane very oblique to the horizon, a method is easily practised, by which the horizontal angles can be approximated very nearly, and thus

we get rid of a common objection to the sextant when applied to such purposes.

Let A and B represent the places of two objects; it is evident that the angular distance will be much too great when taken from one to the other, and that *a b* is the true horizontal angular distance required: now, suppose an object C lying to the right hand of A at the distance of 90° or more, the further the better, if within the limits of the instrument; then it is equally evident that the difference between the angular distance of A and C, and of *a* and C will be but trifling, because of the small quantity of the obliquity in the latter case, and the same may be said of B C and *b* C: hence if the angular distances between A and C, and also B and C are taken, their difference will be a very near approximation to the horizontal angle *a b* which is required, unless the angles of elevation or depression amounted to many degrees. A supposed case or two will make this evident.

We shall suppose A to be 4° above the horizon; B to be 2° below it; C also 1° below; the angular distance as taken by the sextant to be A C = 110°, and A B 20°: now, if we calculate the true angles at the zenith or horizontal angles, it will shew us that in using the instrument thus, we may easily avoid considerable errors. Most commonly we may do very well without such a contrivance, resorting to it only when absolutely necessary.

	°	′	″
The true horizontal angle A C	109	58	46.8
The angular distance A C by sextant	110	0	0
Difference too much by instrument		1.	13.2
The true horizontal angle A B	19	5	25.6
The angular distance A B by sextant	20	0	0
Difference too much by instrument		54	34.4
The true horizontal angle B C	90	53	21.2

The angular distance as would be taken by sextant (N.B. by calcul. it is 90° 51′ 30,7″ which would read 30″ on the limb)	90 51 30
Difference too little by instrument	1 51.2
A C by inst. 110° 0′ 0″, and true horiz. angle by cal.	109 58 46.8
—B C by do. 90 51 30 . . . . ditto	90 53 21.2
A B by ditto 19 8 30 . . . . ditto	19 5 25.6
A B by cal. 19 5 25,6	
3 4,4 differ. between calcul. and measurement.	

This may be considered as an extreme case, and we see that if the angular distance be about 110° with an elevation of 4° and depression of 2°, an error of little more than 1′ is produced; and upon the angle of 90° with a difference of 1° of depression it is nearly 2′; also that in A B an error of 54′ 34.″4 arises from the obliquity of the plane of that angle, but by taking the difference between A C and A B as obtained by the sextant, the required angle is 19° 8′ 30′, whereas by calculation the horizontal angle should be 19° 5′ 25″,6: the error therefore is diminished from 54′ 34″.4 to only 3′ 4″.4; and this upon a distance of 12 inches upon paper, would only become sensible in very acute angles, which should always be avoided as much as possible, even when the best instruments are used. Now 12 inches will represent 3 miles upon a scale of four inches to one mile, the usual scale for military maps. We may therefore conclude, that by avoiding objects in planes very oblique to the horizon, and very acute angles; or by fixing objects from such distances as will bring them into planes almost horizontal, sufficient correctness may be insured, for what is practically true, is as good in these cases as if it were true altogether. We will take a real triangle, whose three angles were 134° 30′ 51″; 29° 30′ 39″; and 15° 58′ 30″; the greatest side 18086 feet. Suppose an error of 3′ + in the second angle, the first remaining the same; then the two smaller become 15° 55′ 30″ and 29° 33′ 39″: the difference between the true and false results will then be 19.2 ft., and 21.29 ft. upon the corres-

ponding sides opposite the two smaller angles, and 20 feet upon the four-inch scale is .06060 of an inch, which is a very small quantity. This is a very strong case, because of the acuteness of the two smaller angles.

We shall now take another instance, where A is 1° above the horizon; B 1° below it; and C 1° above; A B by measurement 32°, and A C 97°.

The true horizontal angle A C	97°	1′	11″
The angular distance by sextant	97	0	0
Difference too little by sextant		1	11
The true horizontal angle A B	31	56	20.6
The angular distance by sextant	32	0	0
Difference too much by sextant		3	39.4
The true horizontal angle B C	65	4	50.4
The angular distance as would be by sextant : (N.B. By calculation it is 65° 4′ 11″.4, but the 11″.4 could not be read upon the limb) . .	65	4	0
Difference too little by sextant	0	0	50.4
A C by inst. 97° 0′ 0″, true horizontal angle by cal.	97	1	11
—B C by do. 65 4 0 ditto ditto	65	4	50.4
A B by ditto 31 56 0 ditto ditto	31	25	20.6
A B by cal. 31 56 20.6			
20.6 diff. between calcul. and measurement.			

In this last supposition which is much nearer the usual practice, the angular distance A B, which would err 3′ 39″.4 from the truth, is obtained by taking the difference between it and A C within 20″.6; the error may therefore be considered as evanescent, for no instrument in general use for laying down angles can do it to less than 1′: in the other angles the difference is also very trifling.

If we are satisfied with such approximations to the truth in horizontal angles as these, which do not exhibit an error of any sensible magnitude in laying down the angles, without great want of care, we may readily conclude that a small instrument not likely to get out of order without violence, which will take them so accu-

rately, is of some consequence to a military man or traveller; but there are many other useful purposes to which it can be applied: a brief examination of them is sufficient in the compass of a short essay, the chief object of which is to draw the attention of travellers to an instrument not so well known or appreciated as it deserves to be, the merits of which were ascertained by many experiments made expressly with a view to determine its powers, and the facts are left to speak for themselves.

For altitudes accessible or not, when the ground is level, very near results may be obtained by means of a small table engraven on the cover: it is simply a table of natural tangents expressed as multipliers or divisions of the radix, and is very useful in finding the heights of churches, columns, or other buildings on level ground; for, with the sextant alone, and without any other tables than this, a base being paced or otherwise measured by a walking-cane, or whatever may be at hand on the occasion, the altitude of such objects may be found within a few inches of the truth.

We will now suppose a traveller about to make a plan or sketch of the site of some ancient town, or any interesting place, and that he has no other instrument than the sextant: we have seen that for lines of 12 inches in length, on paper, it can be depended upon, and the practice of those who use it, is to determine as many points in this manner as may seem necessary, sketching the intermediate objects by the eye: much is certainly left to the eye, but uncertainty may be diminished by determining more points, and thus any assignable degree of correctness will follow. Many hundreds of square miles have been sketched in this manner during the last war, and it has been found to answer extremely well: the military officer or other traveller is thus relieved of the burden of more cumbrous apparatus; a small telescope to find his distant object with more certainty is all the additional assistance required in the field, when his base has been measured, and while the operation of fixing points is going on; a paper containing those points is all he requires in the sketching: his sabretashe holds this paper; and a protractor, with a few drawing instruments at home, completes

the apparatus, by which an active and intelligent officer has surveyed large tracts of mountainous country, with the necessary degree of accuracy and despatch required in such operations.

Without depreciating the larger and truly valuable instruments, the pocket-sextant may be safely recommended to such persons and for such purposes as have been detailed, as a means of adding much useful information to their journals, almost without an additional pound weight to their baggage; but it is by no means wished to be understood, that very scientific surveys are to be superceded by this more simple method: practical accuracy is alone aimed at and most certainly attained, but we do not go beyond that; and in pointing out the advantages of the pocket-sextant to military men and travellers, the writer is desirous of making a marked distinction between the practical results it produces, and the very minute and hairbreadth measurements of a geodesical survey.

To apply so small an instrument to astronomical purposes might seem frivolous; but, when it is considered that mere approximations are sometimes useful where greater accuracy cannot be obtained, it will perhaps be conceded, that even this little instrument will furnish useful information in the absence of those that are more expensive and less portable; particularly in difficult and and dangerous journeys upon mountains, volcanoes, and other places where heavy apparatus is not easily transported, and very likely to be put out of order, or possibly rendered useless: it was possibly for this reason among the instruments taken by a late traveller up Mont Blanc.

The following set of latitudes are inserted just as they came out, in order to shew the utmost variations to which they are liable; all the corrections were applied as usual with capital instruments and from the best tables, that the whole error might fall upon the instrument and the observer.

1822. April 13, Regulas	. . . .	51° 19′ 23.8″
28, Spica Vir.	. . . .	51 19 58.48
29	. . . .	51 19 58.08
30	. . . .	51 19 58.35

		°	′	″
May 15	. . . .	51	19	57.26
16	. . . .	51	19	57.3
Mean of five observations	. . . .	51	19	57.89
April 14, ⊙	. . . .	51	19	52.56
16	. . . .	51	19	37.38
21	. . . .	51	19	12.35
May 5	. . . .	51	19	0.59
Aug. 18	. . . .	51	19	17.
Sept. 1	. . . .	51	19	31
Mean of six observations	. . . .	51	19	25.13
May 15 Polaris	. . . .	51	20	24.2
16	. . . .	51	20	24.14
Mean of two observations	. . . .	51	20	24.17
Aug. 17 α Aquila	. . . .	51	19	9.5
18	. . . .	51	19	9.3
Sept. 10	. . . .	51	19	11
13	. . . .	51	18	58
16	. . . .	51	19	12
Mean of five observations	. . . .	51	19	7.9
1823. Jan. 19, ⊙	. . . .	51	19	46.2
Feb. 21 Rigel	. . . .	51	19	35.4
— Sirius	. . . .	51	19	52.1
Mar. 1 Betelguese	. . . .	51	19	40.49
— Sirius	. . . .	51	19	45.2
Mean of five observations	. . . .	51	19	43.878

				°	′	″
1822.	Regulus	1 observation		51	19	23.8
	Spica	5	. . . . .	51	19	57.89
	⊙ ——	6	. . . . .	51	19	25.13
	Polaris	2	. . . . .	51	20	24.17
	α Aq.	5	. . . . .	51	19	7.9
1823.	Mean of 5 as above		.	51	19	43.878
		Mean of 24 obs.		51	19	40.354, *&c.*

Lat. deduced from observations made with an observatory instrument, and by measurement from observatory	51 20 5.6
Lat. too little by sextant	0 0 25.246

Thus we see that a mean of 24 observations give the latitude within about 25″ of the truth : with fewer and more imperfect observations, a traveller might give us a tolerable account of the latitude in which he travelled, and we all know how frequently this is uncertain to a whole degree or two.

With respect to longitude, it cannot be expected to be determined by lunar observations, by a single person and a single instrument of any kind, so as to become a criterion of the accuracy of that instrument; but, as the time has been always obtained within a few seconds, and sometimes agreeing in two observations to a single second, great hopes may be entertained of the possibility of procuring a near approximation to that also, by the use of two of these sextants, especially when reading to 30″, and if furnished with small telescopes, without which they are certainly not so much to be depended upon.

The following independent results were obtained from separate observations, and may serve to corroborate what has been above advanced :—

	m.	s.
Sept. 1, 1823.		
1st obser. ⊙ l. l. watch fast	1	9
2d	1	7
Sept. 20, α aq. watch fast . . . 1st observation	9	0
2d	8	51.5
3d	9	10.5
Mean of 3	9	0.66

	m.	s.
Oct. 1.		
1st obser. ⊙ u. l. watch fast	14	25
2d	14	24
March 30, 1823.		
1st obs. ⊙ l. l. fast	13	47.52
2d	13	52.20
3d	13	50.32
4th	13	47.36
Mean of 4	13	49.35

June 24, 1823.

☉l. l. 1st. obser. watch slow $\overset{m.}{9}\ \overset{s.}{8}$

2d 9 7

It is needless to multiply instances of this nature; they are sufficient to shew that the above important element in longitude calculation may be approximated to considerable exactness.

The radius being barely 2 inches, they probably cannot be divided more minutely than to 30″; they might, however, be made a little larger, if that were an object, and they would still possess the advantages of having the mirror secured from accident and derangement, which is perhaps a good reason for the constancy of this index error in such small instruments; but, we are now considering them as they are made at present by the best makers, and with a telescope magnifying about four times; although they could carry one magnifying six or eight times, which would be still better. It must be remembered, that an artificial horizon is absolutely necessary on land, for such purposes as those last-detailed.

Art. V. *On the Concretionary and Crystalline Structures of Rocks.* By J. Mac Culloch, M.D., F.R.S., *&c.*

[Communicated by the Author.]

This subject not only forms an important part of the natural history of rocks; but is also interesting, from the hints which it affords respecting the causes which may have acted in their formations. These, and some other points, will be discussed in the course of the following remarks.

Of the Laminar, Foliated, and Schistose Structures.

The most important perhaps, if not the most conspicuous division of structure, is that to which the term *laminar* may be applied. This is the modification which has so often been confounded, under some of its forms, with the stratified disposition; giving rise, in the cases of trap and granite, to serious errors. One of the most interesting varieties in this division occurs in granite. The size of the concretions, if such they are to be considered, is often im-

mense; while, for a certain extent, they sometimes put on the appearance of strata so accurately, that it is not very surprising if they have misled incautious observers. It is not often, however, that the laminar form is so perfect; for, on a careful examination, it will generally be found that the sides of a lamina are far from parallel, and that they speedily disappear in their progress, being irregularly entangled and implicated with others, not only of different sizes, but of various irregular forms. It is not unfrequent for these laminæ to be curved, so as to have a convexity and a concavity; while, in other cases, all their boundaries are convex, causing the laminar to approximate, at length, to a large spheroidal structure. Further, they pass into the cuboidal or square prismatic structure, in consequence of fissures at right angles to their planes. In the same manner, they are sometimes split into imperfect columnar divisions.

The minuteness of the laminar structure is at times such, that granite possessing this character has been called *schistose;* but the difficulty which attends some cases of this nature belongs to a division of geology into which I cannot here enter. It is proper, however, to say, that the larger laminar structure is most frequent in granite; but that it occurs in some of the trap rocks, including porphyries, and is, in particular, very conspicuous in hypersthene rock. The smaller laminæ are found principally in the traps and in pitchstones: and it thus appears that this structure is nearly peculiar to the unstratified rocks.

It occasionally happens, that the laminar structure is only to be discovered after exposure to air, and it may be combined with other varieties, as with the columnar, in many of the trap family.

The circumstances thus detailed respecting the rocks to which this structure belongs, and a careful and unprejudiced eye must be the geologists' guide in distinguishing laminæ from *strata;* a concretionary form, from a real stratification.

The *foliated structure* is distinguished from that properly called laminar, by an undefined, or comparatively unlimited divisibility; and the examples of it are found in the argillaceous schists, in the micaceous schists, in gneiss, and in other analogous primary rocks.

It is conveniently divided into the foliated strictly speaking, and into the schistose.

In the former, which occurs in the primary rocks that contain mica, the divisibility is the result of the position of this mineral; and that position may be the consequence either of deposition or of crystalline polarity. It is unnecessary to dwell on the varieties of aspect which this structure presents, but these will be found to consist, as in gneiss, in its irregularity and imperfection; or, as in the finest and flattest chlorite schists, in its extreme tenuity and flatness. The geologist ought to be careful not to confound it with those appearances which occur in the secondary calcareous or arinaceous strata; which, although strictly laminar forms, have evidently resulted from mechanical deposition, and often from the conspicuous interposition of very slender portions of clay or of mica.

The *schistose structure* is one of those which may truly be called concretionary; as it occurs in a homogeneous rock, and is independent of stratification. It is limited to the argillaceous schists; yet not necessarily to those which are homogenous, as the mixture of sand, gravel, or fragments, does not prevent its existing in the simpler base by which these are united. I must here, however, interpose an exception, not well knowing where else to place it, respecting a peculiar structure occurring in some sandstones, which is neither rigidly laminar, nor properly foliated or schistose. It is the complicated case of the sandstone of Sky, described in the account of the Western Islands, and it is probable that it will hereafter be found in other instances where it has been little expected; in which case it may appear that even the secondary strata may often possess a truly schistose or laminar structure, where the appearances have been attributed to stratification.

The schistose concretionary structure is not necessarily straight, but is sometimes found to be curved, as in clay-slate; and that the curvature belongs to the structure, and not to the bed, is evinced by the regularity or evenness of the latter.

It is possible that this circumstance may tend to explain some of the complicated curvatures that occur in beds of micaceous schist

under similar circumstances; but that all curvature is not of a concretionary origin is proved by a remarkable fact described by me in the Geological Transactions, occurring in the schist in Plymouth-Dock-Yard. Here the rock displays both characters; the contortions being marked by differences of colour, and the schistose structure being at angles to them.

It is not unusual, in the argillaceous schists, for the observer to mistake the direction of the schistose arrangement for the plane of the bed. It is true, that these are sometimes coincident, as in the secondary schists; but in the ancient schists, it is most generally at angles, often very considerable, to the plane of stratification. The mode of making this distinction is stated in the work to which I have so often referred. I may finally add, that no mode of explaining the origin or cause of any of the varieties of the laminar structure has yet been suggested.

Of the Prismatic and Columnar Structures.

The phenomena of decomposition seem to throw some doubt on the existence of any prismatic structure different from the columnar, which is commonly considered as forming a separate division. It is, nevertheless, necessary to describe it according to the form in which it has generally been understood to exist. It is common and well known in granite, and it also occurs in some rocks of the trap family. It is found invariably on the large scale, and is possibly, in these cases, only a modification of the laminar structure produced by fissures. Where it occurs in the sandstones, it appears to be more certainly referable to this cause. When it was thought certain that the spheroidal exfoliation of the cuboids of granite was a proof of a spheroidal concretionary structure, it was natural to consider these as prismatic concretions. That will still be true should this be proved; but as some of the cases of this nature are unquestionably proved to arise from the action of the atmosphere, the whole question must remain open for further enquiry.

The columnar structure on account of its symmetry and artificial appearance, is unquestionably the most interesting of all these modifications: an interest not a little enhanced by the difficulty of explaining its origin. It presents many varieties, occurs in rocks

of very different character, and is apparently, in different situations, produced by distinct causes; circumstances which call for a detail somewhat minute.

The most remarkable forms of this nature are those which exist in the rocks of the trap family. In this division, these columns are of various sizes, ranging from the diameter of less than an inch to one of many feet; and in height, from a foot, to many hundreds of feet. They are almost invariably associated in groups, so as to occupy the whole, or portions of the stratiform beds occasionally found in the trap rocks. In these cases they are generally parallel, with more or less of exactness; but, in some, they are variously and irregularly implicated. Occasionally they are even intermixed with amorphous matter of the same nature. They are, commonly, vertical, because the beds which they divide in a perpendicular manner are horizontal; but they are also occasionally curved. They are often divided by transverse joints of various forms, although sometimes simple. The angles of these columns vary in number, but the prevalent forms lie between the four and seven-sided figures: but it is essentially necessary to remark, that the contact is always perfect; neither vacuity among the angles, nor interval between the approximate sides intervening.

The more imperfect forms of this description gradually pass into an irregular prismatic structure; which at length becomes so indefinite as to be confounded with a mere tendency to vertical fracture.

When these columnar traps are subject to decomposition, it is sometimes observed, that they desquamate in successive crusts, so that a spheroidal nucleus at last remains where there was once a prismatic joint. This has been supposed a proof of a peculiar concretionary structure giving rise to the prismatic form, the arguments respecting which will be immediately considered.

As connected with the trap rocks in their general characters, it is proper to observe, that some lavas occasionally assume the same figures. It has sometimes been said that this occurrence took place only where such lavas came into contact with the sea in the course of their progress; and it has been argued, that a similar

cause may have produced the columnar form in the trap rocks. But the assertion is unfounded; inasmuch as columnar lavas are found where no water can have been present, and amorphous ones occur beneath the sea.

The next case which requires notice in this general account of the columnar structure, is where that form occurs in sandstone; the only two instances with which I am acquainted, are found in the island of Rum, and at Dunbar in Scotland.

The columns that occur in the sandstone of Rum are of small dimensions, not exceeding a few inches in diameter. They lie in the stratum in perfect contact, presenting the usual intermixture of polygonal forms; and what is especially necessary to notice, they are covered by a mass of basalt. At Dunbar, the sandstone in which the columnar arrangement is found, is that which is known to be the lowest of the secondary strata, and which, throughout a great extent of country, presents only the usual stratified character. The columns are limited to a small space, but are of considerable dimensions; attaining to two feet or more in diameter, and to a length of 15 feet or upwards. Where this columnar structure occurs, the character of the rock is changed; becoming more compact, harder, and in some places, passing into a perfect but coarse jasper. In addition to this, it presents the indications of an internal concretionary structure; similar to that which might be inferred to exist in the columns of trap, from the mode in which they are found to desquamate. The transverse sections of each prism are marked by concentric lines of different colours, whitish and reddish; which conform accurately to the sides and angles towards the exterior, but become gradually curved as they approach the centre; indicating the probable existence of a spheroidal nucleus. This disposition is unconnected with any agency of the atmosphere.

As it appears to me that this example, and that of the columnar shales, or argillaceous iron-stones, as they have been called, are in every respect analogous and admit of the same reasoning, it will be as well to describe such examples of these as may be useful in the arguments to be deduced from them. This modification occurs on the large scale in Arran; the prisms being of large diameters,

but divisible by transverse joints into very flat tables, and marked by other peculiarities.

In trying to explain the origin of this structure, it is to be remarked, that the appearance is limited to a small portion of extensive beds which elsewhere preserve their natural characters; and that, in both, particularly in the sandstone, there is a simultaneous change of the mineral character of the rock. The sandstone passes into jasper; that being evidently the case only where, from being intermixed with clay and thus passing into shale, it is of a compound nature. The simple shales that are found in it are indurated; and the purer sandstone is also hardened, so as to resemble some of the varieties of quartz rock. These now are precisely the changes that take place in similar sandstones, where they are found in contact with trap rocks; appearances so well known to all geologists, that it is unnecessary to name any examples, except that in Salisbury Craig near Edinburgh, and that described by myself at Stirling Castle.

It is well known that the masses of trap once incumbent on the upper strata, are often entirely removed; and those who know the ground about Dunbar, are equally aware of the existence of numerous detached portions of these rocks, which, there is every reason to believe, have once been connected into a continuous mass. It is not, therefore, unreasonable to suppose, that such a mass may have once covered that portion of this sandstone, which has undergone that change to jasper which, in other cases, these are known to produce. It is next to be seen whether any facts can be adduced to prove, that the columnar structure was the consequence of the same action.

In Rum, the columnar sandstone actually lies beneath a mass of trap; so that the fact of their simultaneous presence, at least, is proved. This, it is true, is as yet a solitary instance; but here, fortunately, direct experiment comes in aid of the supposition that the action of heat has produced the columnar structure of sandstone. In the hearthstones of iron-furnaces, I have observed, that the sandstones of which they are formed, become divided into polygonal prisms, exactly resembling those of the natural prismatic

sandstones, but, of course, on a small scale. There is, in this case, no shrinking, as in dried clay, to account for the appearance; the sides remaining in perfect contact, just as in the columnar traps. The same circumstance has been observed by Mr. Chantrey, in those sandstones which are heated for the purpose of making roads in Derbyshire. Here therefore it is directly proved, that heat is capable of inducing the prismatic structure in a solid sandstone; and, that this is not the development of an original concretionary structure, is proved by the fact, that in the hearthstones which have undergone this change, the arrangement of the prisms is always vertical to the plane of the stone; a remarkable analogy to their mode of arrangement in the trap rocks.

Ignorant as we are of the nature of the concretionary structure, it is still certain that it bears a kind of analogy to crystallization; and the well known experiments of Mr. Watt, prove that this arrangement, if it be not rather a concretionary one, may take place in rocks without fluidity. It is also known, that a curved structure is sometimes developed in rocks by heat. The present discussion may, perhaps, render it doubtful whether this is not rather the generation of a concretionary structure. It is impossible to pursue this argument further, for want of a greater store of facts. It must be left to make that impression on unprejudiced readers, which is all that an imperfect train of reasoning is entitled to expect.

Yet, in terminating these observations, it is right to remark, that the decided union of the concentric arrangement with the prismatic form in the sandstone of Dunbar, renders it probable, that this arrangement exists also in the prisms of trap; invisible from want of contrast of colour or texture, and only developed on wasting.

It remains to enquire whether this fact may not be analogically extended to account for the columnar forms of the trap rocks. Different causes have been assigned for this by geologists. It has been supposed to result from the division of a mass of a soft and moist material, by drying and consequent shrinking; and it has been attributed to crystallization from a state of igneous fluidity, or from solution in water. It is useless to examine that theory

which conceives that it arose from the contact of fluid trap with water. That would scarcely explain its nature, even were this a fact proved, which it is not. There is no resemblance between the prisms of trap and those formed by the shrinking of clay: the essential difference lies in the absolute contact of the former, and that objection is insurmountable. To call the arrangement of a basaltic prism crystallization, is, on the other hand, entirely to lose sight of the true nature of this mode of arrangement, which consists in the production of definite geometrical figures by the repeated addition of particles of a definite form, whether these be simple atoms, or compounded chemical molecules. In the prisms of trap, the laws of geometry and chemistry are equally violated; and the objection applies equally to both modes of crystallization, whether from solution or fusion.

On the other hand, it appears, that sandstones exposed to heat do assume the prismatic form, while it is certain, that the trap rocks must have often retained their heat long after they had lost their fluidity. It is unnecessary to draw out the argument further. The prismatic form might have occurred even after the rock was consolidated: if any additional facility is gained by the supposition, this change may be conceived to have gradually taken place while a state of tenacity still permitted a certain degree of motion among the parts.

A small and irregular prismatic disposition is sometimes found in the pitchstones, as well as among the traps; and it can scarcely be considered as more than a modification of the laminar form into which it passes. In certain argillaceous ironstones and jaspers there has also been observed a prismatic arrangement on a small scale; which is further often singularly marked by protuberant joints, or by small stripes or channels parallel to the prisms. A similar arrangement exists in that substance, called madreporite limestone, from its resemblance to an organic structure. Respecting these, there is nothing further known, from which an explanation of the causes of these arrangements can be derived.

There is yet one modification of prismatic structure remaining, which requires notice; on account of the misapprehensions which

were entertained by Dr. Hutton respecting its cause, and from its misapplication in the support of his views. This relates to the ironstones known by the name of *septaria*, which consist of spheroids, generally uniform on the outside, but divided within into polygonal figures, of which the intervals are filled by calcareous spar. It was supposed by him, that these stones had experienced the influence of fire, and that, in the act of consolidation, the calcareous matter had been separated from the compound mass; it having been conceived impossible that it could have entered from without. But the solution of this difficulty is exceedingly simple; and the occurrence is an obvious instance of the shrinking of a mass of moist earth. In some of the septaria, the external surface is not solid, but the prisms reach it; and, in these cases, the ease with which carbonate of lime might have entered into the intervals is evident. Where the surface, on the contrary, is unbroken, it is no less easy to understand how, during the drying of such a nodule of clay, that part would first consolidate; while the interior would necessarily shrink and split, from the dissipation of the water through a substance unquestionably capable of permitting its transudation. The subsequent infiltration of lime into the cavities thus formed, is not only easy to apprehend, but is a fact of daily occurrence in rocks of a far more compact nature, namely in the traps; the amygdaloidal cavities of which are sometimes filled in this manner.

Of the Spheroidal Structure.

The spheroidal structure is found under different modifications; some of which are among the most inexplicable phenomena of this nature which geology presents. The explanation of those which approach in their nature to crystallization, is not so difficult; and these examples serve, in some measure, to connect two processes, otherwise very different.

The large spheroidal structure of granite, already mentioned, cannot perhaps with propriety be ranked with this; and, for the same reason, I shall omit that which occurs in trap in Rum, although a very remarkable occurrence.

In the secondary sandstones of Egg and other places, there are found large spheroids imbedded in the ordinary strata. These are

distinguished by a greater hardness of texture than the surrounding rock, whence they are easily separated as it wastes away. Their own texture is also unequal; and it not unfrequently happens that the superficies is cracked into polygons. How far the influence of trap may have tended to the production of these must be conjectured from the circumstances respecting the prismatic structures of sandstone, from the fact that these spheroidal sandstones also occur in the vicinity of trap. I may here add, that concretions of large size have lately been brought from the new-discovered land of South Shetland, consisting of the halves of very flattened spheroids; as if such figures had been cut through, according to their equatorial diameters, by a sharp tool.

In the argillaceous limestone, as well as in the accompanying sandstones of Sky, highly flattened spheroids of large dimensions are found attached in pairs by a cylindrical stem, and imbedded in the surrounding rock; from which they are easily separated on its destruction, on account of their superior hardness. They bear no resemblance to organic forms; and although they have also been observed in other parts of Europe, no explanation of their origin has been suggested. It need only further be remarked, that these also occur in the vicinity of trap rocks.

The smaller kinds of spheroidal structure are more numerous, and present greater variety. In the siliceous schist of the Shiant Isles and Scalpa, it is ascertained by decomposition, that the internal structure consists of small aggregated spheroids; the intervals of which, being of a different nature, become converted into clay on exposure, leaving a botryoidal surface. In the fresh rock this cannot be suspected. The softer shales of the former islands are also frequently found to consist of an aggregation of spherules not larger than mustard-seed. In these cases also trap is present; and it is easily proved that the rocks in question were once the ordinary shales of the coal strata, which, in undergoing induration, have also experienced this change of structure. Where some of the claystones of Arran are invaded by trap veins, it is found that they assume in some places an imperfect spheroidal tendency; which gradually becomes more perfect where they approxi-

mate to the trap; while their substance, at the same time, is converted into an anomalous stone resembling those cherts which have been sometimes called *hornstone.* An inequality of the internal texture is here also ascertained by the botryoidal surface which these assume on exposure to the sea.

It is now important to remark, that these spherules, wherever the forms are most perfect, present a concretionary structure, passing into one which is decidedly crystalline. Brilliant fibres radiate from the centre, and are repeated at intervals, so as to form successive concentric crusts of the same nature; or else these crystalline spheres are surrounded with crusts, in which no fibrous structure can be traced. There is thus a transition from the most perfect crystalline to the most imperfect concretionary spherule.

In attempting to explain these appearances, it is striking to observe how these spheroidal crystallized forms coincide with those which occur in glass under certain circumstances, and how accurately they resemble the analogous appearances produced in Mr. Watt's well-known experiments. In these it was remarked, that the crystalline arrangement was enabled to proceed after the fused trap had lost its fluidity. Thus it is equally easy to comprehend how a solid mass of any or the above-named rocks, softened, if it is necessary to suppose so, without fusion, or otherwise under the long-continued influence of heat, might have assumed a similar species of structure. As also in one of these cases there is a gradual progress from the most perfect crystalline to the most imperfect concretionary arrangement, there can be no reason to doubt that, in every case, the latter may also be produced by the same causes. It should lastly be added, in confirmation of this theory, that a spheroidal structure of a similar nature exists in the trap of the Shiant Isles.

A spheroidal structure, terminating also by wasting in botryoidal forms, has been observed in certain limestones, as in that of Sunderland. A similar arrangement is occasionally found in the sandstones; and sometimes, in the red varieties, it is indicated by the presence of white spheroidal spots. Of these no explanation has been suggested, and I have none to offer.

The spheroidal structure of the oölite limestones of England appears to be merely an aggregation of rounded grains, and requires no notice. That of the pisolites, which consist of crustaceous agglutinated spherules, is probably the result of a deposition from water; the exact nature of which is not very apparent. I shall here forbear any remarks on the spheroidal structure of pearlstone, as it was treated of in an article formerly published in this Journal.

Of the Venous, Cavernous, Fibrous, and Scaly Structures.

In many rocks it may be observed, that where the surfaces have been exposed to the weather, they present a reticulated appearance, as if from the intersection of veins, of a nature harder than the general mass of the rock. On breaking such rocks, however, no corresponding appearances are found in the interior; the whole mass presenting an uniform texture and colour. This peculiarity is very frequent in granite; but it occurs also in gneiss, in micaceous schist, and in the sandstones. It has been conceived to arise from some original structure, but is at best a very obscure circumstance. It deserves notice, perhaps principally, because it has been used as an argument to prove that all veins are of similar origin, or, in other words, that, in the ordinary acceptation of the term, no such thing as a vein exists. The analogy is clearly one of those superficial ones calculated to operate only on minds of a similar structure; while, if there is any one fact in geology that is beyond the regions of dispute, it is that of the posteriority of veins to the substances which they traverse.

A cavernous structure, sometimes rendered visible in sandstones by decomposition, may almost be considered as a variety of this; since the separation of the cells may be considered as formed by such durable intersecting laminæ. The appearances which attend some of these cavernous and reticulating structures are often very singular; but as they are only discovered by decomposition, they belong more properly to the history of that process. That they depend on some internal arrangement produced subsequent to the deposition of the strata, can admit of no doubt; but, respecting the nature of this, we can only as yet confess our ignorance.

The fibrous structure is the last which can strictly be enumerated among the concretionary modifications; and it seems to unite them with those that are properly of a crystalline nature. It is known to occur in the carbonates of lime, as in the satin spar, and in the limestones of Egg. In the former, it is more decidedly crystalline than in the latter, resembling the corresponding arrangement so frequent in gypsum. It is also not very uncommon in the argillaceous schists; in which, as these are not susceptible of the crystalline arrangement, it must necessarily be referred to the concretionary structure. Its cause involves exactly the same difficulties as those which attend the explanation of the schistose structure. It is only necessary to observe of many other fibrous arrangements seen in rocks, including that which has been called *bladed*, that they are purely crystalline; their peculiar aspect being produced by the lengthened forms and parallel arrangements of the crystals.

Of the scaly structure, it is unnecessary to say more than that it is one of those which, when it occurs in rocks of a crystalline character, must be considered as among the first in the order of crystalline arrangements. As a consequence of the mechanical deposition of the flat parts or scales, it requires no notice in this place.

Of the Porphyritic, Granular, and Amygdaloidal Structures.

The structure called porphyritic, is purely crystalline, and is that which confers the peculiar character on the porphyries. It is by no means, however, deficient in interest; as it is only known in those rocks which appear to have derived their origin from fusion. When, indeed, we consider that, in this case, a single crystal of a perfect form is surrounded by an uncrystallized mass, it offers in itself a proof of the species of fluidity under which the whole must have been consolidated. No imagination can assign an expedient for producing this effect from a watery solution; while the existence of the porphyritic structure in volcanic rocks affords every proof of the nature of its origin that can be desired.

The granular structures that belong to the sandstones and conglomerates, being purely mechanical, need not be noticed; but

the granular structure of granite, and the analogous rocks, being of a crystalline nature, are here deserving of regard. It has been maintained that this structure has been the produce of watery solution; since many geologists still chuse to consider granite of aqueous origin, notwithstanding its analogy, nay, its identity, in almost every circumstance of composition, texture, and accidents, with the trap rocks, to which they admit an igneous one. The argument, as far as its texture or structure is concerned, belongs properly to this place.

Granting the greatest facilities to the preceding supposition, by admitting the solution in water of earths noted for the extremely limited degree in which they possess this property, and granting, still further, that they were able, under these circumstances, to enter into all the multifarious combinations which are to produce quartz, feldspar, mica, hornblende, and many other minerals, it remains to invent a new process in the chemistry of crystallization, by which all these new combinations should have been in an instant deposited together in a solid mass. If a successive deposition of the different minerals be conceived, it is impossible to explain the mutual interference which takes place among them, and which characterises the crystalline granular structure. The imagination that would produce such an effect from such causes, must not be allowed to flit about vague generalities, but is bound to contemplate steadily every minute circumstance implied in such a process.

But nature and art both are ready to prove that this effect takes place without difficulty from fusion. The glasses of our furnaces separate into various mineral compounds on cooling. The same results take place from the cooling of fused basalts, where the previous combinations have all been dissolved by one general fluidity. In the trap rocks, the granitic structure is common; and these, it is granted, are the products of fusion. The lavas of volcanoes, if it could be necessary to insist on facts so well known, are in a state of liquid fusion, in which every integrant earth is left free to enter into such combinations as the infinite complication of affinities may direct. If these are cooled suddenly, they are arrested before they can enter into new compounds, and glass is

the result. If, on the contrary, sufficient time be granted, the consequence is the generation of numerous minerals, producing not only the granitic structure, but the porphyritic also. It is not necessary here to argue the question of graphic granite, which was originally brought forward to prove the same conclusion; since the basis of the reasoning is the same.

The last structure to be noticed is the amygdaloidal, and it is preferable that it should be examined here, that the whole of the subject of structure, as far as it forms an object of geological theory, should be seen in one condensed view. That its nature has been a subject of dispute, is an additional reason for introducing it among other subjects equally matters of controversy. If the view of its cause here to be given shall be admitted, it will be seen, however, that it has no proper title to rank among the modifications of the concretionary structure.

The variety of minerals contained in the cavities of amygdaloids, does not form any part of this enquiry; but it is necessary to state, that this structure is limited to the trap family and to the volcanic rocks. It is universally admitted, that the cells of volcanic scoria have been produced by aëriform matters disengaged during the process of fusion. Similar cells are found in the trap rocks, as I have elsewhere shown (Western Islands), and these rocks have also been produced in the same manner.

Now the cells which, in either of these classes of rock, contain the amygdaloidal minerals, differ in no respect in form and disposition from those that are empty; and if their internal surfaces be examined, it will be found that they are often coated with a similar vitreous varnish. These cavities are not always filled with the minerals which they contain; but present vacuities, in which it frequently happens that the crystalline terminations of the minerals are defined. In the next place, two minerals, or even more, are sometimes found in one cavity; in some cases interfering with each other's forms. Lastly, similar cavities occur in the same rocks, sometimes of considerable size, yet connected by a gradation of magnitude with the smaller cells. These seem to be the circumstances most essential to the argument under review.

Partly, perhaps, from the existence of amydgaloidal nodules in volcanic rocks, and partly from a supposed necessity for thinking that every mineral contained in a trap rock must necessarily be, like its base, of igneous origin, it has been argued by Dr. Hutton and Mr. Playfair, that these minerals also were the produce of fusion, and that they had been secreted during the cooling of the rock, so as, in fact, to form the cavities which they occupy. I need not state here the various minute details, sometimes neither very intelligible nor very requisite, by which this opinion was supported. The igneous theory of trap would be feeble indeed, had it no firmer foundation than this to rest on; while the notion of a chemical secretion is, to say the least of it, inconsistent with all our chemical experience.

It is quite intelligible that crystals of any mineral should be formed in a fluid mass of the earths, as they are in porphyries and in many volcanic products, during the very process of consolidation; but it is not to be explained how they should in this manner form rounded nodules; still less how the cavities that include them should ever be partially empty, or present the peculiar surface already described. The vacant spaces must have contained an elastic fluid; and when we find that these vacancies are similar in their forms and surfaces to the cavities that are entirely filled, and to those that are utterly empty, it is a fair conclusion that the whole alike owe their origin to inflation. It is then into previous cavities that the minerals of the amygdaloids have been deposited; and it only remains to enquire whether this has been effected during the igneous condition of the rock, or from posterior infiltrations of a watery solution of earths. It must not here be objected that the larger cavities could not have been produced by inflation; for as will presently be seen, it is in those, more particularly, that the proofs of watery infiltration are more satisfactory. To examine this question first.

I have shown in the account of the Western Islands and elsewhere, that stalactites of chalcedony were often found to depend from the upper parts of such cavities partly filling the vacuity. In other cases, the stalactite is found to correspond with an inferior

stalagmite; offering a case precisely resembling that which occurs in the ordinary calcareous stalactites of caverns. Lastly, the dependant stalactite is more or less perfectly imbedded in a laminar chalcedony, rising from the bottom of the cavity till it is at last destined to fill it, and thus to form a solid nodule. If any appearances can prove a watery infiltration of silicious matter, these are of that nature. In other instances, the silicious stalactite is involved in calcareous spar, which, as in the former case, either leaves an empty space or fills the whole; forming a compound amygdaloidal nodule. Here it is evident that the calcareous spar is posterior to the stalactite; and thus also a watery infiltration of two minerals into one cavity is proved.

It is easy to extend this reasoning to the ordinary case of the concentric agate nodules, which may or may not contain calcareous spar. In these cases, the siliceous matter has been deposited by a more gradual infiltration over the whole of the surface of the air vesicle; producing the concentric appearance of the coats, in consequence of the successive deposition of a material differing in texture or colour. If the agate contains a central portion of calcareous spar, it is obviously only a variation of the former case. It is thus also easy to explain, why the agate sometimes contains an interior covering of siliceous crystals, from changes that have taken place in the quality of the solution: these presenting their usual geometric forms, or else being confused accordingly as the cavity is filled or not.

It must not be objected to this explanation, that siliceous earth is insoluble in water; because that is proved by numerous facts, and by none more decidedly than the existence of vegetable remains in chalcedony. Nor must it be said that the solid substances in question cannot transmit water. Water is known to exist in rocks, even in the traps, and to find a passage through many, much more solid than the amygdaloidal bases, as is proved by the daily formation of calcareous stalactites. I have also shown, in a paper in the *Edinburgh Journal*, that the agates are sufficiently porous to transmit oil, and also sulphuric acid; that property being the basis of the process used for staining them black. There is therefore no

difficulty in understanding, both how the rocks should admit the mineral solutions into their cavities, and how the first crust of agate should permit the deposition, not only of successive ones of the same nature, but, from changes in the nature of the solution, of calcareous spar also.

One source of the amygdaloidal nodule is thus established, but it does not follow that this is the sole one. The minerals which these cavities contain are numerous and various, and we have no proof that some of them can be formed by aqueous deposition; while it is certain that they are sometimes produced from fusion, as they are found constituting imbedded parts of the volcanic rocks. I have shewn in the *Geological Transactions*, that silica can be sublimed by heat; and the same fact has been affirmed to occur in the volcanic products of Vesuvius, by observers whose testimony cannot be questioned. It is possible that compound minerals may be subjected to the same laws; and it is also perfectly intelligible, how in a fluid or tenacious rock containing the cavities produced by inflation, those minerals which have sometimes crystallized in the general mass, should have also protruded themselves into the cavities.

There are probably, therefore, two origins to be assigned to the amygdaloidal nodules, both of the trap rocks and the volcanic products; however the mode of explaining the igneous method may here differ from that adopted by Dr. Hutton. Admitting them both, the question respecting the igneous origin of the amygdaloidal bases of the trap rocks, rests precisely on the same foundation as before; as the essential circumstance consists, not in the presence of the nodule, but in the formation of the cavity that contains it.

Of the Nature of the Concretionary Structure.

Having thus terminated all which it appeared requisite to say respecting several varieties of concretionary structure, it remains to see if any light can be thrown on the general nature of this mysterious process.

That it differs essentially from crystallization, was already no-

ticed. It is neither concerned in the disposition of original and similar molecules, nor in arranging them into geometric forms. Yet its phenomena bespeak a tendency in the particles, or finer fragments constituting stones, to arrange themselves, by a predominant attraction, into certain forms rather than others; however irregular or uninfluenced by geometrical rules these may be. A simple and obvious instance of this tendency may be seen in the disposition assumed by fine powders or sand under water, where these are therefore free to move.

That it exists in bodies fluid from fusion, is proved by the appearances that occur in the slow-cooling of liquid basalts artificially fused. Lastly, that it may happen in solid bodies, is proved by the phenomena which take place in heated sandstones. If the improbability of this latter case should be objected, it must be remembered that, in Mr. Watt's experiments, the crystalline change took place in the trap after it had ceased to be fluid; that the experiments of Dr. Brewster point out the changes which take place in the crystallization of solid glass from changes of temperature; and that those of Reaumur prove analogous changes in the same substances at higher temperatures, still short of fusion. In a series of experiments instituted for the same purpose, I have also proved that every metal can change its crystalline arrangement while solid, and many of them at very low temperatures. In fact the power of motion in the particles of solid bodies, is proved by their changes of dimension on alternations of temperature; and it is not therefore extraordinary that in those which have the properties of crystallizing, a tendency to their peculiar crystalline forms should occur. It is also not surprising if, being thus in motion, they should assume other or less regular forms, as they do from the fluid state.

We have uo right to assume that the parts of such matter may not have the power, by mutual attraction, of assuming forms that are not geometrical, even though they should be heterogeneous and shapeless; knowing nothing of the nature and laws of that force by which similar and definite molecules affect geometrical ones. The limit between crystalline and mechanical attraction

may be undefined, and so may the resulting forms. Thus the concretionary structure may bear a real analogy to crystallization, or it may even be supposed a modification of that process. We know that it exists; we are ignorant alike of the laws of both. But that they have a real connection is proved by the phenomena above-recited, respecting the smaller spheroidal structures. In these, it is absolutely impossible to define the point at which the one ceases and the other commences. The radiated crystalline spherula passes into one consisting of solid unradiated concentric crusts; and that again, in a manner equally gradual, into a solid sphere without any internal structure.

I know not that at present any further light can be thrown on this obscure subject, which I willingly leave to other hands and to further information. As far as relates to the magnitude of some of the masses considered as concretionary, there is no cause for objections. We can even see no reason why nature might not have produced a crystal of mountainous bulk, provided the requisite circumstances were present. The polar tendency of crystallization is often prolonged through various obstacles, as is daily seen in minerals: it may be protracted indefinitely along the atoms of a compound mass, as is evinced by the granite vein in Coll, which I have elsewhere described. The tendency to form certain concretions may equally be unlimited; and thus it need excite no surprise if even the granitic laminæ of the Alps, which have been supposed the products of an extensive but disturbed stratification, have been produced by a concretionary arrangement analogous to crystallization.

Art. VI. *Astronomical Phenomena arranged in Order of Succession, for the Months of October, November, and December, in the Year* 1824. *By* James South, F.R.S.

(Continued from Page 297, Vol. XVII.*)*

OCTOBER.

Days.	Planet's or Star's Name, &c.	Magnitude of Stars.	Sidereal Time. H. M.	Planet's or Star's Declination. D. M.
1	Sun		12 30	3 16 S
	Mercury..		12 34	6 14 S
	Venus ...		13 35	9 15 S
	Moon....		20 2	19 13 S
	XX. 80...	7.8	20 11	18 52 S
	11 ρ Capr..	5	20 19	18 23 S
	15 V—...	5	20 30	18 45 S
2	Sun		12 34	3 39 S
	Mercury..		12 34	6 14 S
	Venus ...		13 40	9 43 S
	XX. 341..	7.8	20 43	13 51 S
	Moon....		20 51	15 24 S
	Im. *	7	20 55 or 11^{h} 56′ MT.	
	*'s R.A. 20^{h} 57′ Decl. 14° 37′ S. (3′N.)			
	XX. 7 ...	7.8	21 2	15 11 S
	18 Aquar..	6	21 15	13 37 S
	Em. * ...		21 48 or 12^{h} 49′ MT. (7′S)	
	Im. 2 Sat.		2 39 or 13^{h} 52′ MT. (+100)	
3	Sun		12 37	4 3 S
	Venus ...		13 41	10 12 S
	19 Aquar..	6	21 16	10 29 S
	XXI. 134.	7.8	21 19	12 19 S
	23 ξ. Aqu.	5	21 28	8 38 S
	Moon....		21 38	10 59 S
	Im. * 1 ..	7.8	1 7 or 12^{h} 16′ MT.	
	*'s R.A. 21^{h} 44′ Decl. 10° 14′ S. (4′N.)			
	Im. * 2...	7.8	1 11 or 12° 20′ MT.	
	*'s R.A. 21^{h} 43′ Decl. 10^{h} 9′ S. (8′N.)			
	Em. * 1..		2 12 or 13^{h} 21′ MT. (10′S.)	
	Em. * 2..		2 17 or 13^{h} 26′ MT. (5′S.)	
	Im. * 3 ..	7.8	4 24 or 15^{h} 33′ MT.	
	*'s R.A. 21^{h} 48′ Decl. 9° 25′ S. (12′N.)			
	Em. * 3..		5 11 or 16^{h} 20′ MT. (2′N.)	
	Mercury..		12 27	4 47 S
4	Sun		12 41	4 26 S
	Venus ...		13 49	10 40 S
	XXII. 2..	6.7	22 1	5 8 S
	44 Aquar.	6.7	22 8	6 16 S
	51 — ..	6	22 15	5 43 S
	Moon....		22 23	6 11 S
	Im. *	6	2 27 or 13^{h} 33′ MT.	
	1 *'s R.A. 22^{h} 29′ Decl. 5° 8′ S. (13′N.)			
	Em. * ...		6 35 or 14^{h} 27′ MT. (1′N.)	
	Mercury..		12 21	4 4 S
5	Sun		12 45	4 49 S
	Venus ...		13 54	11 9 S
	1 Pisc....	6	22 46	0 8 N

Days.	Planet's or Star's Name, &c.	Magnitude of Stars.	Sidereal Time. H. M.	Planet's or Star's Declination. D. M.
	2 Pisc....	6.7	22 50	0 2 N
	Moon....		23 7	1 10 S
	XXIII. 68.	6.7	23 15	0 40 S
	Im. *	5.6	5 40 or 16^{h} 40′ MT.	
	*'s R.A. 23^{h} 18′ Decl. 0° 18′ N. (6′N.)			
	Em. * ...		6 35 or 17^{h} 35′ MT. (6′S.)	
	Mercury..		12 22	3 26 S
6	Sun		12 48	5 12 S
	Venus ...		13 59	11 37 S
	17 ι Pisc..	4.5	23 31	4 41 N
	XXIII. 170	7	23 36	6 13 N
	26 —— ..	6	23 46	6 6 N
	Moon....		23 52	3 56 N
	Im. 1 Sat.		4 11 or 15^{h} 9′ MT. (+100)	
	Mercury..		12 19	2 47 S
7	Sun		12 52	5 35 S
	Venus ...		14 3	12 6 S
	O. 110 ...	7	0 25	9 20 N
	O. 140 ...	7.8	0 31	10 34 N
	Moon....		0 39	8 55 N
	O. 255...	8	0 52	10 14 N
	Mercury..		12 17	2 9 S
8	Sun		12 56	5 58 S
	Venus ..		14 8	12 33 S
	87 Pisc...	6.7	1 5	15 12 N
	Im *.....	6	1 16 or 12^{h} 6′ MT.	
	*'s R.A. 1^{h} 26′ Decl. 13° 46′ N. (cont.)			
	99 η Pisc..	4	1 22	14 26 N
	Moon....		1 27	13 35 N
	Mercury..		12 16	1 45 S
9	Sun		12 59	6 21 S
	Venus ...		14 13	13 0 S
	15 Ariet..	6	2 1	18 40 N
	22 θ 1—..	6	2 8	19 5 N
	Moon....		2 19	17 39 N
	II. 112...	6.7	2 24	18 6 N
	Im. 4 Sat..		3 30 or 14^{h} 16′ MT. (+100)	
	Im. * ...	6.7	5 20 or 16^{h} 5′ MT.	
	*'s R.A. 2^{h} 24′ Decl. 18° 6′ N. (3′S.)			
	Im. 2 Sat..		5 41 or 16^{h} 26′ MT. (+100)	
	Em. *		6 28 or 17^{h} 13′ MT. (4′S.)	
	Mercury..		12 15	1 20 S
10	Sun		13 3	6 44 S
	Venus ...		14 18	13 27 S
	Im. * 1 .	7	20 10 or 6^{h} 53′ MT.	
	*'s R.A. 2^{h} 59′ Decl. 20° 5′ N. (15′S.)			
	Em. * 1 ..		20 35 or 7^{h} 18′ MT. (11′S.)	

OCTOBER.

Days.	Planet's or Star's Name, &c.	Magnitude of Stars.	Sidereal Time. H. M.	Planet's or Star's Declination. D. M.
	Im. * 2 ..	5	22 31 or $9^h 13'$ MT.	
	*'s R.A. $3^h 5'$ Decl. 20° 23′ N. (9′N.)			
	Em. * 2..		23 27 or $10^h 9'$ MT. (2′N.)	
	Im. 3 Sat..		2 18 or $13^h 0'$ MT. (+100)	
	Moon....		3 12	20 53 N
	Em. 3 Sat.		5 48 or $16^h 29'$ MT. (+100)	
	Mercury..		12 14	0 56 S
11	Sun		13 7	7 6 S
	Venus ...		14 22	13 54 S
	Im. * 1 ..	7.8	22 10 or $8^h 49'$ MT.	
	1 *'s R.A. $3^h 58'$ Decl. 22° 38′ N. (13′N.)			
	Em. * 1..		22 48 or $9^h 27'$ MT. (8′N.)	
	Im. * 2 ..	7	3 55 or $14^h 33'$ MT.	
	*'s 2 R.A. $4^h 10'$ Decl. 23° 10′ N. (11′N.)			
	Moon....		4 9	22 59 N
	Em. * 2..		4 49 or $15^h 27'$ MT. (7′N.)	
	Mercury..		12 15	0 46 S
12	Sun		13 10	7 29 S
	Venus ...		14 27	14 20 S
	Mercury..		12 16	0 36 S
13	Sun		13 14	7 52 S
	Venus ...		14 32	14 47 S
	Im. * 1 ...	5	21 48 or $8^h 18'$ MT.	
	*'s R.A. $5^h 53'$ Decl. 23° 16′ N. (3′S.)			
	Em. *....		22 31 or $9^h 1'$ MT. (7′S.)	
	Im. * 2 ..	8	4 48 or $15^h 17'$ MT.	
	*'s R.A. $6^h 9'$ Decl. 23° 20′ N. (12′N.)			
	Em. * ...		5 27 or $15^h 56'$ MT. (13′N)	
	Im. 1 Sat..		6 33 or $17^h 2'$ MT. (+100)	
	Mercury..		12 17	0 26 S
14	Sun		13 18	8 14 S
	Venus....		14 37	15 12 S
	Im. *	7	1 55 or $12^h 21'$ MT.	
	*'s R.A. $7^h 0'$ Decl. 21° 33′ N. (cont.)			
	Im. *	5.6	7 37 or $18^h 2'$ MT.	
	*'s R.A. $7^h 12'$ Decl. 20° 46′ N. (3′S.)			
	Em. *		8 45 or $19^h 10'$ MT. (7′N.)	
	Mercury..		12 20	0 33 S
15	Sun		13 22	8 36 S
	Venus ...		14 42	15 36 S
	Im. *	8	0 48 or $11^h 11'$ MT.	
	*'s R.A. $7^h 55'$ Decl. 18° 7′ N. (1′N.)			
	Em. *		1 39 or $12^h 1'$ MT. (2′N.)	
	Mercury..		12 22	0 40 S
16	Sun		13 25	8 58 S
	Venus ...		14 47	16 1 S
	Mercury..		12 25	0 47 S
17	Sun		13 29	9 21 S
	Venus ...		14 52	16 26 S
	Im. 3 Sat.		6 44 or $16^h 58'$ MT.	
	Im. *	6	7 50 or $18^h 3'$ MT.	
	*'s R.A. $10^h 0'$ Decl. 7° 2′ N. (16′N.)			
	Em. *		8 1 or $18^h 14'$ MT. (13′N)	
	Mercury..		12 29	1 7 S
18	Sun		13 33	9 42 S
	Venus ...		14 57	16 50 S
	Mercury..		12 32	1 27 S
19	Sun		13 37	10 4 S
	Venus ...		15 2	17 15 S
	Im. *	6	4 56 or $15^h 2'$ MT.	
	*'s R.A. $11^h 42'$ Decl. 4° 21′ S. (15′S.)			
	Em. * ...		5 31 or $15^h 27'$ MT. (6′S.)	
	Mercury..		12 36	1 47 S
20	Sun		13 40	10 26 S
	Venus ...		15 7	17 37 S
	Im. * ...	5.6	8 33 or $18^h 35'$ MT.	
	*'s R.A. $12^h 45'$ Decl. 10° 41′ S. (2′N.)			
	Em. * ...		9 23 or $19^h 24'$ MT. (14′N)	
	Mercury..		12 41	2 16 S
21	Sun		13 44	10 47 S
	Venus ...		15 12	17 59 S
	Mercury..		12 46	2 44 S
22	Sun		13 48	11 9 S
	Venus ...		15 17	18 21 S
	Im. 1 Sat.		3 30 or $13^h 24'$ MT. (98)	
	Mercury..		21 51	3 13 S
23	Sun		13 52	11 30 S
	Venus ...		15 22	18 43 S
	Mercury..		12 56	3 48 S
24	Sun		13 56	11 51 S
	Venus ...		15 27	19 5 S
	Mercury..		13 2	4 22 S
25	Sun		13 59	12 12 S
	Venus ...		15 32	19 27 S
	Mercury..		13 7	4 57 S
26	Sun		14 3	12 32 S
	Venus ...		15 37	19 45 S
	Im. * 1 ..	7	18 55 or $4^h 35'$ MT.	
	*'s R.A. $17^h 54'$ Decl. 24° 24′ S. (15′N.)			
	Im. * 2 ..	7	19 0 or $4^h 40'$ MT.	
	*'s R.A. $17^h 54'$ Decl. 24° 24′ S. (14′N.)			
	Em. * 1..		16 31 or $5^h 11'$ MT. (12′N)	
	Em. * 2..		19 39 or $5^h 19'$ MT. (12′N)	
	Em. 4 Sat.		2 51 or $12^h 20'$ MT. (94)	
	Mercury..		13 13	5 35 S
27	Sun		14 7	12 53 S
	Venus ...		15 42	20 4 S
	Moon....		18 48	22 59 S
	Im. *	6.7	19 42 or $5^h 18'$ MT.	
	*'s R.A. $18^h 51'$ Decl. 32° 56′ S. (2′N.)			
	Em. * ...		20 51 or $6^h 27'$ MT. (5′S.)	
	Mercury .		13 19	6 13 S
28	Sun		14 11	13 13 S
	Venus ...		15 47	20 22 S

OCTOBER.

Days.	Planet's or Star's Name, &c.	Magnitude of Stars.	Sidereal Time. H. M.	Planet's or Star's Declination. D. M.
	Moon....		19 42	20 17 S
	Im. *....	8	22 1 or $7^h 33'$ MT.	
	*'s R.A. 19^h 45′ Decl. 19° 41′ S. (14′N.)			
	Em. * ...		22 12 or $7^h 44'$ MT. (12′N)	
	Mercury..		13 25	6 51 S
29	Sun		14 15	13 33 S
	Venus ...		15 52	20 41 S
	Im. * ...	6.7	19 1 or $4^h 29'$ MT.	
	*'s R.A. 20^h 31′ Decl. 16° 45′ S. (12′N.)			
	Em. * ...		20 3 or $5^h 31'$ MT. (3′N)	
	Moon....		20 32	16 42 S
	XX. 367..	8	20 45	15 56 S
	XX. 386..	7	20 48	16 42 S
	XX. 461..	8	20 57	16 26 S
	Im. 1 Sat.		5 51 or $15^h 17'$ MT. (91.)	
	Mercury..		13 31	7 31 S
30	Sun		14 19	13 52 S
	Venus ...		15 57	20 59 S
	Im. * 1 ..	7.8	18 37 or $4^h 2'$ MT.	
	*'s R.A. 21^h 17′ Decl. 12° 50′ S. (7′N.)			

Days.	Planet's or Star's Name, &c.	Magnitude of Stars.	Sidereal Time. H. M.	Planet's or Star's Declination. D. M.
	Im. * 2 ..	9	19 43 or $5^h 9'$ MT.	
	*'s R.A. 21^h 19′ Decl. 12° 41′ S. (3′N.)			
	Im. * 3 ..	10	19 49 or $5^h 13'$ MT.	
	*'s R.A. 21^h 19′ Decl. 12° 51′ S. (5′S.)			
	Em. * 1..		19 52 or $5^h 16'$ MT. (5′S.)	
	Im. * 4 ..	7.8	20 24 or $5^h 48'$ MT.	
	*'s R.A. 21^h 18′ Decl. 12° 25′ S (cont.)			
	Em. * 3..		20 41 or $6^h 5'$ MT. (14′S.)	
	Em. * 2..		21 2 or $6^h 26'$ MT. (1′N.)	
	XXI. 82..	7.8	21 12	12 12 S
	19 Aquar.	6	21 16	10 29 S
	Moon....		21 20	12 30 S
	48 λ Capri	5.6	21 37	12 10 S
	Mercury..		13 36	8 10 S
31	Sun		14 23	14 12 S
	Venus ...		16 2	21 18 S
	XXI. 350	8	21 50	7 7 S
	30 Aquar.	5.6	21 54	7 22 S
	XXI. 403	8	21 59	7 14 S
	Moon....		22 5	7 56 S

NOVEMBER.

Days.	Planet's or Star's Name, &c.	Magnitude of Stars.	Sidereal Time. H. M.	Planet's or Star's Declination. D. M.
1	Sun		14 27	14 31 S
	Venus ...		16 7	21 33 S
	15 ζ Aquar.	4	22 20	0 55 S
	60 ———	6.7	22 25	2 28 S
	XXII. 183	7.8	22 32	4 28 S
	Moon....		22 50	2 57 S
	Saturn ...		4 19	19 20 N
	Mercury..		13 48	9 30 S
2	Sun		14 30	14 50 S
	Venus ...		16 12	21 51 S
	16 Pisc...	6	23 27	1 8 N
	17 ι ———	4.5	23 31	4 41 N
	Moon....		23 35	2 6 N
	22 Pisc...	6	23 43	1 57 N
	Im. *....	6	0 51 or $10^h 3'$ MT.	
	*'s R.A. 23^h 37′ Decl. 2° 31′ N. (7′N.)			
	Em. * ...		2 6 or $11^h 18'$ MT. (8′S.)	
	Saturn ...		4 19	19 19 N
	Mercury..		13 54	10 10 S
3	Sun		14 34	15 9 S
	Venus ...		16 18	22 6 S
	Im. *....	6	21 41 or $6^h 49'$ MT.	
	*'s R.A. 0^h 17′ Decl. 6° 43′ N. (13′ N.)			
	Em. * ...		22 42 or $7^h 50'$ MT. (1′N)	
	35 Pisc...	6	0 6	7 51 N
	41 d.....	5.6	0 12	7 13 N

Days.	Planet's or Star's Name, &c.	Magnitude of Stars.	Sidereal Time. H. M.	Planet's or Star's Declination. D. M.
	Moon....		0 21	7 8 N
	O 135 ...	8	0 30	6 57 N
	Saturn ...		4 19	19 18 N
	Im. 2 Sat..		4 20 or $13^h 27'$ MT. (86)	
	Mercury..		14 0	10 49 S
4	Sun		14 38	15 28 S
	Venus....		16 23	22 20 S
	75 Pisc...	6.7	0 57	12 1 N
	Moon....		1 8	11 55 N
	99 η Pisc..	4	1 22	14 26 N
	Im. *....	7.8	1 24 or $10^h 28'$ MT.	
	*'s R.A. 1^h 9′ Decl. 12° 12′ N. (14′N.)			
	120 π Pisc.	6	1 28	11 14 N
	Em. * ...		2 26 or $11^h 30'$ MT. (2′N)	
	Saturn ...		4 18	19 18 N
	Mercury..		14 6	11 29 S
5	Sun		14 42	15 46 S
	Venus ...		16 28	22 35 S
	Im. * 1 ..	7	20 6 or $5^h 7'$ MT.	
	*'s R.A. 2^h 41′ Decl. 18° 26′ N. (cont.)			
	4 Arietis..	6.7	1 39	16 5 N
	8 ι ———.	6	1 49	16 57 N
	1243.....	6	1 54	17 24 N
	Moon....		1 59	16 14 N
	Im. * 2 ..	7	2 0 or $11^h 0'$ MT.	
	*'s R.A. 2^h 0′ Decl. 16° 24′ N. (10′N.)			

NOVEMBER.

Days.	Planet's or Star's Name, &c.	Magnitude of Stars.	Sidereal Time. H. M.	Planet's or Star's Declination. D. M.
	Em. * ...		3 11	or 12h 11' MT. (1'S.)
	Saturn ...		4 18	19 17 N
	Im. * 3 ..	7	6 12	or 15h 11' MT.
	*'s R.A. 2h 59' Decl. 20° 5' N. (4' S.)			
	Em. * ...		7 8	or 16h 7' MT. (9'S)
	Im. 1 Sat.		8 12	or 17h 11' MT. (84)
	Im. * 4 ..	5	8 57	or 17h 56' MT.
	*'s R.A. 3h 5' Decl. 20° 33' N. (3'N.)			
	Em. * ...		9 47	or 18h 46' MT. (1'S)
	Mercury..		14 12	12 7 S
6	Sun		14 46	16 4 S
	Venus ...		16 34	22 49 S
	47 Arietis.	6	2 48	19 58 N
	Moon....		2 53	19 48 N
	II. 261. ..	7	2 59	20 5 N
	58 ζ Ariet.	5	3 5	20 23 N
	Saturn ...		4 18	19 16 N
	Mercury..		14 19	12 45 S
7	Sun		14 50	16 22 S
	Venus ...		16 34	22 49 S
	Im. * 1 ..	7	21 58	or 6h 50' MT.
	*'s R.A. 3h 40' Decl. 21° 42' N.			
	Em. *		22 53	or 7h 45' MT. (5'S)
	Im. * 2 ...	6	1 30	or 10h 22' MT.
	*'s R.A. 3h 46' Decl. 21° 58' N. (8'S.)			
	Em. * ...		2 15	or 11h 7' MT. (13'S)
	Im. 1 Sat.		2 47	or 11h 39' MT. (82.)
	III. 144 ..	5	3 36	23 23 N
	III. 172 ..	7.8	3 40	23 25 N
	Moon....		3 49	22 20 N
	Saturn ...		4 17	19 15 N.
	Mercury..		14 25	13 23 S
8	Sun		14 54	16 40 S
	Venus ...		16 44	23 15 S
	Im. * 1 ..	7.8	0 56	or 9h 44' MT.
	*'s R.A. 4h 43' Decl. 23° 15' N. (6'S.)			
	Em. * ...		1 48	or 10h 36' MT. (10'S.)
	Im. * 2 ..	8	2 47	or 11h 35' MT.
	*'s R.A. 4h 46' Decl. 23° 7' N. (11'N.)			
	Im. * 3 ..	6.7	3 8	or 11h 56' MT.
	*'s R.A. 4h 47' Decl. 23° 40' N. (10'N.)			
	Em. * 2..		3 37	or 12h 25' MT. (9'N.)
	Em. * 3.		4 1	or 12h 49' MT. (7'N.)
	Saturn ...		4 17	19 15 N
	IV. 162 ..	7	4 33	23 45 N
	IV. 243 ..	6.7	4 47	23 40 N
	Moon....		4 50	23 32 N
	IV. 295 ..	6	4 57	24 1 N
	Mercury..		14 31	13 59 S
9	Sun		14 58	16 57 S
	Venus ...		16 50	23 25 S
	Im. * 1 ..	8	21 14	or 5h 59' MT.

Days.	Planet's or Star's Name, &c.	Magnitude of Stars.	Sidereal Time. H. M.	Planet's or Star's Declination. D. M.
	*'s R.A. 5h 33' Decl. 23° 7' N. (4'S.)			
	Em. * ...		21 56	or 6h 40' MT. (5'S.)
	Im. * 2 ..	7	0 35	or 9h 19' MT.
	*'s R.A. 5h 41' Decl. 23° 20' N. (4'N.)			
	Em. * ...		1 27	or 10h 11' MT. (1'N)
	Saturn ...		4 17	19 14 N
	Moon....		5 51	23 15 N
	Im. * 3 ..	5	6 55	or 15h 38' MT.
	*'s R.A. 5h 53' Decl. 23° 16' N. (3'N.)			
	Em. * ...		7 55	or 16h 38' MT. (7'N.)
	Im. * 4 ..	6	9 50	or 18h 33' MT.
	*'s R.A. 5h 59' Decl. 23° 8' N. (8'N.)			
	Im. * 5...	7	10 10	or 18h 52' MT.
	*'s R.A. 6h 0' Decl. 23° 1' N. (3'N.)			
	Em. * 4..		10 32	or 19h 14' MT. (12'N)
	Em. * 5..		11 0	or 19h 42' MT. (8'N)
	Mercury..		14 37	14 36 S
10	Sun		15 2	17 14 S
	Venus ...		16 55	23 36 S
	Im. * 1 ..	7	23 27	or 8h 7' MT.
	*'s R.A. 6h 37' Decl. 21° 52' N. (1 N.)			
	Em. *		0 16	or 8h 56' MT. (2'N)
	Im. * 2 ..	6.7	1 2	or 9h 42' MT.
	*'s R.A. 6h 41' Decl. 21° 58' N. (9'N.)			
	Em. * ...		1 46	or 10h 26' MT. (10'N)
	Saturn ...		4 16	19 13 N
	Im. 2 Sat.		7 23	or 16h 2' MT. (79)
	Mercury..		14 43	15 12 S
11	Sun		15 6	17 31 S
	Venus ...		17 0	23 47 S
	Im. * 1 ..	6	23 59	or 8h 35' MT.
	*'s R.A. 7h 36' Decl. 18° 56' N. (5'S.)			
	Em. * ...		0 46	or 9h 22' MT. (1'S.)
	Im. * 2 ..	7	0 57	or 9h 33' MT.
	*'s R.A. 7h 38' Decl. 18° 46' N. (11'S.)			
	Im. * 3 ..	6.7	1 0	or 9h 36' MT.
	*'s R.A. 7h 38' Decl. 18° 46' N. (11'S.)			
	Em. * 2..		1 29	or 10h 5' MT. (8'S.)
	Em. * 3..		1 32	or 10h 8' MT. (8'S.)
	Im. * 4 ..	7	1 33	or 10h 9' MT.
	*'s R.A. 7h 39' Decl. 18° 37' N. (cont.)			
	Saturn ...		4 16	19 12 N
	Mercury..		14 50	15 47 S
12	Sun		15 11	17 47 S
	Venus ...		17 6	23 57 S
	Saturn ...		4 16	19 11 N
	Im. *	7	8 38	or 17h 9' MT.
	*'s R.A. 8h 49' Decl. 19° 0' N. (4'N.)			
	Em. * ...		9 56	or 18h 26' MT. (14'N)
	Mercury..		14 57	16 21 S
13	Sun		15 15	18 3 S
	Venus ...		17 11	24 8 S

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Days.	Planet's or Star's Name, &c.	Magnitude of Stars.	Sidereal Time.	Planet's or Star's Declination.	Days.	Planet's or Star's Name, &c.	Magnitude of Stars.	Sidereal Time.	Planet's or Star's Declination.
			H. M.	D. M.				H. M.	D. M.
	Saturn ...		4 16	19 11 N		Venus ...		17 55	24 51 S
	Im. * 1 ..	6.7	5 20 or 13^h 48′ MT.			Saturn ...		4 13	19 4 N
	*'s R.A. 9^h 36′ Decl. 9° 23′ N. (3′S.)					Im. 1 Sat.		7 30 or 15^h 25′ MT. (68)	
	Em. *		6 23 or 14^h 51′ MT. (10′N)		22	Sun		15 52	20 13 S
	Im. * 2 ..	7	7 24 or 15^h 52′ MT.			Mercury..		15 54	20 56 S
	*'s R.A. 9^h 42′ Decl. 8° 57′ N. (4′S.)					Venus ...		18 0	24 53 S
	Em. * ...		8 23 or 16^h 51′ MT. (11′N)			Saturn ...		4 12	19 3 N
	Mercury..		15 3	16 56 S		Im. 3 Sat.		4 56 or 12^h 48′ MT. (67)	
14	Sun		15 19	18 19 S		Em. 3 Sat.		8 27 or 16^h 19′ MT. (67)	
	Venus ..		17 16	24 14 S	23	Sun		15 56	20 25 S
	Saturn ...		4 15	19 10 N		Mercury..		16 1	21 20 S
	Im. 1 Sat.		5 8 or 13^h 32′ MT. (75)			Venus ...		18 5	24 55 S
	Mercury..		15 9	17 28 S		Saturn ...		4 12	19 2 N
15	Sun		15 23	18 34 S	24	Sun		16 0	20 37 S
	Venus ...		17 22	24 21 S		Mercury.		16 7	21 45 S
	Em. 3 Sat.		4 0 or 12^h 20′ MT. (74)			Venus ...		18 11	24 57 S
	Saturn ...		4 15	19 9 N		Im. *	7.8	23 3 or 6^h 48′ MT.	
	Im. * 1 ..	7.8	4 23 or 12^h 43′ MT.			*'s R.A. 19^h 25′ Decl. 21° 9′ S. (10′S.)			
	*'s R.A. 11^h 20′ Decl. 2° 1′ S. (12′N.)					Em. * ...		23 34 or 7^h 19′ MT. (14′S.)	
	Im. * 2 ..	4.5	4 45 or 13^h 5′ MT.			Saturn ...		4 12	19 1 N
	*'s R.A. 11^h 21′ Decl. 2° 2′ S. (8′N.)				25	Sun		16 5	20 49 S
	Em. * 1..		5 10 or 13^h 30′ MT. (cont.)			Mercury..		16 14	22 9 S
	Em. * 2..		5 35 or 13^h 55′ MT. (6′S.)			Venus ...		18 16	24 59 S
	Mercury..		15 16	18 1 S		Moon....		20 10	18 11 S
16	Sun		15 27	18 49 S		Saturn ...		4 11	19 1 N
	Venus ...		17 27	24 27 S	26	Sun		16 9	21 1 S
	Saturn ...		4 15	19 8 N		Mercury..		16 21	22 30 S
	Im. *	8	9 6 or 17^h 21′ MT.			Venus ...		18 21	24 57 S
	*'s R.A. 12^h 22′ Decl. 8° 29′ S. (6′S.)					Moon....		21 0	14 8 S
	Em. * ...		9 43 or 17^h 58′ MT. (15′S.)			XXI. 59 .	8	21 9	12 59 S
	Mercury..		15 22	18 33 S		18 Aquar.	6	21 15	13 37 S
17	Sun		15 31	19 4 S		XXI. 134.	7.8	21 19	12 19 S
	Venus ...		17 33	24 34 S		Saturn ...		4 11	19 0 N
	Saturn ...		4 14	19 7 S	27	Sun		16 13	21 12 S
	Im. 2 Sat.		10 26 or 18^h 37′ MT. (72)			Mercury..		16 27	22 51 S
	Mercury..		15 28	19 2 S		Venus ...		18 27	24 54 S
18	Sun		15 35	19 18 S		23 ξ Aqu..	5	21 28	8 38 S
	Venus ...		17 38	24 40 S		46 c. 1 Ca.	6	21 36	9 53 S
	Saturn ...		4 14	19 6 N		Moon....		21 46	9 39 S
	Mercury..		15 34	19 32 S		36 Aquar.	7	22 0	9 3 S
19	Sun		15 39	19 33 S		Im. * ...	7.8	22 31 or 6^h 5′ MT.	
	Venus ...		17 44	24 47 S		*'s R.A. 21^h 48′ Decl. 9° 25′ S. (5′N.)			
	Saturn ...		4 14	19 6 N		Em. * ...		23 26 or 7^h 0′ MT. (15′S.)	
	Im. *	7.8	10 48 or 18^h 51′ MT.			Saturn ...		4 11	18 59 N
	*'s R.A. 15^h 12′ Decl. 22° 16′ S. (15′S.)				28	Sun		16 18	21 23 S
	Em. * ...		11 28 or 19^h 31′ MT. (8′S)			Mercury..		16 34	23 12 S
	Mercury..		15 40	20 1 S		Venus ...		18 32	24 52 S
20	Sun		15 44	19 46 S		Im. * 1 ..	6	19 55 or 3^h 35′ MT.	
	Venus ...		17 49	24 49 S		*'s R.A. 22^h 29′ Decl. 5° 8′ S. (14′N.)			
	Saturn ...		4 13	19 5 N		Em. * ...		21 3 or 4^h 33′ MT. (2′S)	
	Mercury..		15 47	20 28 S		51 Aquar.	6	22 15	5 43 S
21	Sun		15 48	20 0 S		60 —— ...	6.7	22 25	2 28 S

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Days.	Planet's or Star's Name, &c.	Magnitude of Stars.	Sidereal Time. H. M.	Planet's or Star's Declination. D. M.
	Moon....		22 32	4 50 S
	XXII. 219	7.8	22 39	5 8 S
	Im. * 2 ..	7.8	23 10	or $5^h 39'$ MT.
	*'s R.A. $22^h 32'$ Decl. $4° 28'$ S. (cont.)			
	Im. * 3 ..	8	23 37	or $7^h 6'$ MT.
	*'s R.A. $22^h 33'$ Decl. $4° 23'$ S. (14′N.)			
	Em. * ...		0 55	or $8^h 24'$ MT. (1′N)
	Im. 2 Sat.		3 1	or $10^h 30'$ MT. (61)
	Im. * 4 ..	7	3 13	or $10^h 42'$ MT.
	*'s R.A. $22^h 38'$ Decl. $3° 38'$ S. (14′N.)			
	Em. * ...		3 58	or $11^h 27'$ MT. (5′N.)
	Saturn ...		4 10	18 58 N
	Im. 1 Sat.		9 51	or $17^h 19'$ MT. (61)
29	Sun		16 22	21 33 S
	Mercury..		16 40	23 30 S
	Venus ...		18 38	24 49 S
	Moon....		23 16	0 9 N
	16 Pisc ..	6	23 27	1 8 N

Days.	Planet's or Star's Name, &c.	Magnitude of Stars.	Sidereal Time. H. M.	Planet's or Star's Declination. D. M.
	18 λ ——.	5	23 33	0 49 N
	XXIII.193	7.8	23 40	1 15 N
	Im. * 1...	5.6	0 7	or $7^h 3[illegible]'$ MT.
	*'s R.A. $23^h 18'$ Decl. $0° 18'$ N. (7′N.)			
	Im. * 2 ..	6	0 38	or $8^h 4'$ MT.
	*'s R.A. $23^h 18'$ Decl. $0° 10'$ N. (cont.)			
	Em. * 1..		0 46	or $8^h 12'$ MT (14′N)
	Saturn ...		4 10	18 57 N
	Im. 3 Sat.		9 22	or $16^h 46'$ MT. (60)
30	Sun		16 26	21 43 S
	Mercury..		16 47	23 48 S
	Venus ...		18 43	24 47 S
	17 Pisc ..	4.5	23 31	4 41 S
	26 ——..	6	23 46	6 6 N
	28 ω —..	4.5	23 50	5 54 N
	Moon....		0 1	5 8 N
	Saturn ..		4 10	18 57 N
	Im. 1 Sat.		4 26	or $11^h 47'$ MT. (59)

DECEMBER.

Days.	Planet's or Star's Name, &c.	Magnitude of Stars.	Sidereal Time. H. M.	Planet's or Star's Declination. D. M.
1	Sun		16 30	21 52 S
	Mercury..		16 54	24 4 S
	Venus ...		18 49	24 44 S
	58 Pisc ..	6	0 38	11 1 N
	Moon....		0 48	10 0 N
	O. 257...	7.8	0 52	10 58 N
	75 Pisc ..	6.7	0 57	12 1 N
	Saturn ...		4 9	18 56 N
2	Sun		16 35	22 1 S
	Mercury..		17 1	24 18 S
	Venus ...		18 54	24 37 S
	Im. * ...	7	20 9	or $3^h 24'$ MT.
	*'s R.A. $1^h 29'$ Decl. $13° 24'$ N. (3′S.)			
	Em. *....		20 58	or $4^h 12'$ MT. (4′S.)
	87 Pisc ..	6.7	1 5	15 12 N
	99 η	4	1 22	14 26 N
	105——..	6	1 30	15 31 N
	Moon....		1 36	14 30 N
	Saturn ...		4 9	18 55 N
3	Sun		16 39	22 10 S
	Mercury..		17 8	24 32 S
	Venus ...		19 0	24 30 S
	Im. *....	6.7	23 9	or $6^h 19'$ MT.
	*'s R.A. $2^h 24'$ Decl. $18° 6'$ N. (14′N.)			
	Em. * ...		23 53	or $7^h 3'$ MT. (7′S.)
	22 ϑ1 Ariet	6	2 8	19 5 N
	26———.	6.7	2 21	19 4 N
	Moon....		2 29	18 24 N

Days.	Planet's or Star's Name, &c.	Magnitude of Stars.	Sidereal Time. H. M.	Planet's or Star's Declination. D. M.
	34 μ Ariet.	6	2 32	19 16 N
	Saturn ...		4 9	18 54 N
4	Sun		16 44	22 18 S
	Mercury..		17 15	24 45 S
	Venus ...		19 5	24 23 S
	66 Arietis.	6.7	3 18	22 12 N
	Moon....		3 25	22 25 N
	III. 115...	7.8	3 32	22 13 N
	III. 166...	7	3 40	21 42 N
	Saturn ...		4 8	18 53 N
5	Sun		16 48	22 26 S
	Mercury..		17 22	24 55 S
	Venus....		19 10	24 15 S
	Im. * 1 ..	7.8	21 51	or $4^h 53'$ MT.
	*'s R.A. $4^h 12'$ Decl. $22° 33'$ S. (4′S.)			
	Em. * ...		22 36	or $5^h 38'$ MT. (10′S.)
	Im. * 2 ..	7	1 23	or $8^h 25'$ MT.
	*'s R.A. $4^h 20'$ Decl. $23° 11'$ N. (10′N.)			
	Im. * 3 ..	7	1 49	or $8^h 51'$ MT.
	*'s R.A. $4^h 21'$ Decl. $22° 58'$ N. (7′S)			
	Em. * 2..		2 20	or $9^h 22'$ MT. (4′N.)
	Em. * 3..		2 39	or $9^h 41'$ MT. (12′S.)
	Saturn ...		4 8	18 53 N
	62 Tauri..	7	4 13	23 53 N
	72 υ 2....	6	4 17	22 36 N
	Moon....		4 24	23 13 N
	IV. 162 ..	7	4 33	23 45 N
	Im. 2 Sat.		6 5	or $13^h 6'$ MT. (54)

DECEMBER.

Days.	Planet's or Star's Name, &c.	Magnitude of Stars.	Sidereal Time. H. M.	Planet's or Star's Declination. D. M.
	Im. * 4 ..	6.7	9 32 or 16^h 32′ MT.	
	*'s R.A. 4^h 35′			Decl. 23° 18′ N. (9′S.)
	Em. * ..		10 16 or 17^h 16′ MT. (9′S.)	
6	Sun		16 52	22 33 S
	Mercury..		17 29	25 5 S
	Venus ...		19 15	24 8 S
	Saturn ...		4 8	18 52 N
	IV. 295 ..	6	4 57	24 1 N
	108 Tauri.	7	5 5	22 5 N
	118 ——	7	5 18	25 0 N
	Moon....		5 26	23 32 N
7	Sun		16 57	22 40 S
	Mercury..		17 35	25 15 S
	Venus ...		19 21	24 1 S
	Im. * 1 ..	3	22 23 or 5^h 18′ MT.	
	*'s R.A. 6^h 12′			Decl. 22° 36′ N. (8′N.)
	Em. * ...		23 1 or 5^h 55′ MT. (8′N.)	
	Saturn ...		4 7	18 51 N
	Im. * 2 ..	7	5 36 or 12^h 29′ MT.	
	*'s R.A. 6^h 29′			Decl. 22° 11′ N. (8′S.)
	Moon....		6 29	22 14 N
	Em. * 2..		6 38 or 13^h 31′ MT. (4′S.)	
	Im. 1 Sat..		6 47 or 13^h 40′ MT. (52)	
	Im. * 3 ..	7	10 3 or 16^h 56′ MT.	
	*'s R.A. 6^h 37′			Decl. 21° 52′ N. (2′N.)
	Em. * ...		10 57 or 17^h 50′ MT. (8′N.)	
8	Sun		17 1	22 46 S
	Mercury..		17 42	25 21 S
	Venus ...		19 26	23 50 S
	Im. * 1 ..	8	23 27 or 6^h 17′ MT.	
	*'s R.A. 7^h 14′			Decl. 20° 20′ N. (12′N.)
	Em. * ...		23 57 or 6^h 47′ MT. (15′N)	
	Im. * 2 ..	7	1 10 or 8^h 0′ MT.	
	*'s R.A. 7^h 19′			Decl. 19° 59′ N. (6′S.)
	Im. * 3 ..	7.8	1 35 or 8^h 25′ MT.	
	*'s R.A. 7^h 20′			Decl. 20° 11′ N. (11′N.)
	Em. * 2..		2 2 or 8^h 52′ MT. (4′S.)	
	Em. * 3..		2 12 or 9^h 2′ MT. (14′N)	
	Saturn ...		4 7	18 50 N
	Moon....		7 30	19 21 N
	Im. * 4 ..	6	9 41 or 16^h 29′ MT.	
	*'s R.A. 7^h 36′			Decl. 18° 56′ N. (7′S.)
	Em. * ...		10 46 or 17^h 34′ MT. (4′N.)	
	Im. * 5...	7	10 49 or 17^h 37′ MT.	
	*'s R.A. 7^h 38′			Decl. 18° 46′ N. (5′S.)
	Im. * 6 ..	6.7	10 53 or 17^h 41′ MT.	
	*'s R.A. 7^h 38′			Decl. 18° 46′ N. (5′S.)
	Im. * 7...	7	11 11 or 17^h 59′ MT.	
	*'s R.A. 7^h 39′			Decl. 18° 37′ N. (10′S.)
	Em. * 5..		11 50 or 18^h 38′ MT. (6′N.)	
	Em. * 6..		11 54 or 18^h 42′ MT. (6′N.)	
	Em. * 7..		12 7 or 18^h 55′ MT. (1′N.)	
9	Sun		17 5	22 52 S
	Mercury..		17 49	25 27 S
	Venus ...		19 31	23 39 S
	Saturn ...		4 7	18 49 N
	Im. *	7.8	5 33 or 12^h 19′ MT.	
	*'s R.A. 8^h 26′			Decl. 15° 55′ N. (13′N.)
	Em. * ...		6 1 or 12^h 47′ MT. (17N.)	
10	Sun		17 10	22 58 S
	Mercury..		17 56	25 32 S
	Venus ...		19 36	23 28 S
	Saturn ...		4 6	18 49 N
	Im. *	6	6 11 or 12^h 52′ MT.	
	*'s R.A. 9^h 23′			Decl. 10° 29′ N. (15′S.)
	Em. * ...		7 0 or 13^h 41′ MT. (5′S.)	
11	Sun		17 14	23 3 S
	Mercury..		18 3	25 33 S
	Venus ...		19 42	23 17 S
	Im. * 1...	7	3 21 or 9^h 59′ MT.	
	*'s R.A. 10^h 23′			Decl. 5° 33′ N. (6′S.)
	Em. * ...		3 38 or 10^h 16′ MT. (12′S.)	
	Saturn ...		4 6	18 48 N
	Im. * 2...	6	8 21 or 14^h 58′ MT.	
	*'s R.A. 10^h 34′			Decl. 4° 30′ N. (3′N.)
	Em. * ...		9 27 or 16^h 4′ MT. (16′S.)	
	Im. * 3...	7.8	9 39 or 16^h 16′ MT.	
	*'s R.A. 10^h 35′			Decl. 4° 9′ N. (16′S.)
	Im. * 4...	6.7	9 45 or 16^h 22′ MT.	
	*'s R.A. 10^h 36′			Decl. 4° 14′ N. (9′S.)
	Em. * 3..		10 24 or 17^h 1′ MT. (6′S.)	
	Em. * 4..		10 56 or 17^h 33′ MT. (7′N.)	
12	Sun		17 19	23 7 S
	Mercury..		18 10	25 35 S
	Venus ...		19 47	23 5 S
	Saturn ...		4 6	18 47 N
	Im. * 1...	7	6 47 or 13^h 20′ MT.	
	*'s R.A. 11^h 23′			Decl. 0° 49′ S. (cont.)
	Em *		7 52 or 14^h 25′ MT. (7′N)	
	Im. * 2...	7.8	8 30 or 15^h 3′ MT.	
	*'s R.A. 11^h 26′			Decl. 1° 15′ S. (11′S.)
	Im. * 3...	7.8	9 0 or 15^h 33′ MT.	
	*'s R.A. 11^h 26′			Decl. 1° 31′ S. (cont.)
	Im. 2 Sat..		9 9 or 15^h 41′ MT. (47)	
	Em. * 2..		9 29 or 16^h 2′ MT. (2′N.)	
13	Sun		17 23	23 11 S
	Mercury..		18 16	25 36 S
	Venus ...		19 52	22 54 S
	Saturn ...		4 5	18 47 N
	Im. *	7.8	9 22 or 12^h 52′ MT.	
	*'s R.A. 12^h 4′			Decl. 6° 19′ S. (3′S.)
	Em. * ...		7 18 or 13^h 48′ MT. (11′N)	
14	Sun		17 27	23 15 S
	Mercury..		18 23	25 33 S

DECEMBER.

Days.	Planet's or Star's Name, &c.	Magnitude of Stars	Sidereal Time. H. M.	Planet's or Star's Declination. D. M.
	Venus..		19 57	22 39 S
	Saturn..		4 5	18 46 N
	Im. 1 Sat		9 8 or $15^h 33'$ MT. (45)	
15	Sun ...		17 32	23 18 S
	Mercury		18 30	25 29 S
	Venus .		20 3	22 23 S
	Saturn .		4 5	18 45 N
	Im. 4 Sat.		7 49 or $14^h 11'$ MT. (44)	
	Em. 4 Sat		12 17 or $18^h 37'$ MT. (44)	
16	Sun		17 36	23 21 S
	Mercury.		18 36	25 26 S
	Venus ..		20 8	22 8 S
	Im. 1 Sat		3 44 or $10^h 2'$ MT. (43)	
	Saturn ..		4 5	18 44 N
17	Sun		17 41	23 23 S
	Mercury.		18 42	25 18 S
	Venus..		20 13	21 52 S
	Saturn .		4 4	18 44 N
	Im. * ...	7	11 56 or $18^h 9'$ MT.	
	*'s R.A. $16^h 6'$ Decl. 23° 50′ S. (12′S.)			
	Em. * .		12 44 or $18^h 57'$ MT. (6′S.)	
	Im. * ..	5.6	13 57 or $20^h 10'$ MT.	
	*'s R.A. $16^h 10'$ Decl. 23° 44′ S. (8′N.)			
	Em. * .		14 45 or $20^h 58'$ MT. (13′N)	
18	Sun ...		17 45	23 25 S
	Mercury .		18 50	25 10 S
	Venus .		20 19	21 37 S
	Saturn .		4 4	18 43 N
	Im. *	3.4	15 14 or $21^h 22'$ MT.	
	*'s R.A. $17^h 11'$ Decl 24° 49′ S. (6′N.)			
	Em. * ...		16 13 or $22^h 21'$ MT. (1′S)	
19	Sun		17 50	23 26 S
	Mercury..		18 57	25 2 S
	Venus ...		20 24	21 21 S
	Saturn ...		4 4	18 42 N
	Im. 2 Sat.		12 12 or $18^h 17'$ MT. (40)	
20	Sun		17 54	23 27 S
	Mercury..		19 4	24 50 S
	Venus ...		20 29	21 2 S
	Saturn ...		4 3	18 42 N
21	Sun		17 59	23 28 S
	Mercury..		19 11	24 37 S
	Venus ...		20 34	20 43 S
	Saturn ...		4 3	18 41 N
	Im. 1 Sat..		11 30 or $17^h 27'$ MT′ (38)	
22	Sun		18 3	23 28 S
	Mercury..		19 17	24 25 S
	Venus ...		20 39	20 24 S
	Saturn ...		4 3	18 41 N
23	Sun		18 7	23 27 S
	Mercury..		19 23	24 8 S
	Venus ...		20 44	20 5 S
	Saturn ...		4 3	18 40 N
	Im. 1 Sat..		6 5 or $11^h 55'$ MT. (36)	
24	Sun		18 12	23 26 S
	Mercury..		19 29	23 52 S
	Venus ...		20 49	19 46 S
	Saturn ...		4 2	18 39 N
25	Sun		18 16	23 21 S
	Mercury..		19 35	23 35 S
	Venus ...		20 54	19 27 S
	Moon....		22 13	6 50 S
	Im. *	7.8	0 52 or $6^h 36'$ MT.	
	*'s R.A. $22^h 17'$ Decl. 6° 4′ S. (10′N.)			
	Em. * ...		2 5 or $7^h 48'$ MT. (4′S.)	
	Saturn ...		4 2	18 39 N
26	Sun		18 21	23 23 S
	Mercury. .		19 41	23 15 S
	Venus ...		20 59	19 4 S
	3 Pisc....	6	22 52	0 45 S
	Moon....		22 57	1 53 S
	XXIII. 68	6.7	23 15	0 40 S
	12 Pisc...	7	23 21	2 0 S
	Im. * 1...	7.8	23 54 or $5^h 33'$ MT.	
	*'s R A. $22^h 59'$ Decl. 1° 27′ S (8′N.)			
	Im. * 2...	7.8	0 29 or $6^h 8'$ MT.	
	*'s R.A. $22^h 59'$ Decl. 1° 15′ S. (cont.)			
	Em. * 1..		1 14 or $6^h 52'$ MT. (8′S.)	
	Saturn ...		4 2	18 38 N
27	Sun		18 25	23 20 S
	Mercury..		19 47	22 54 S
	Venus ...		21 4	18 41 S
	10 ϑ Pisc..	5	23 19	5 25 N
	17 ι ——	4.5	23 31	4 41 N
	19 ——	6	23 37	2 31 N
	Moon....		23 42	3 6 N
	Saturn ...		4 1	18 38 N
28	Sun		18 30	23 17 S
	Mercury..		19 53	22 34 S
	Venus ...		21 9	18 18 S
	35 Pisc...	6	0 6	7 51 N
	O 85.....	8	0 21	7 50 N
	Moon....		0 28	7 58 N
	O 140....	7.8	0 31	10 34 N
	Im. 3 Sat..		3 7 or $8^h 38'$ MT. (31)	
	Im. *	7	3 37 or $9^h 8'$ MT.	
	*'s R.A. $0^h 31'$ Decl. 8° 24′ (cont.)			
	Saturn ...		4 1	18 37 N
	Em. 3 Sat.		6 39 or $12^h 10'$ MT. (31)	
29	Sun		18 34	23 14 S
	Mercury..		19 58	22 11 S
	Venus ...		21 14	17 56 S
	Moon....		1 14	12 33 N
	99 η Pisc..	4	1 22	14 26 N

DECEMBER.

Days.	Planet's or Star's Name, &c.	Magnitude of Stars.	Sidereal Time.	Planet's or Star's Declination.	Days.	Planet's or Star's Name, &c.	Magnitude of Stars.	Sidereal Time.	Planet's or Star's Declination.
			H. M.	D. M.				H. M.	D. M.
	101 Pisc..	6	1 26	13 46 N		Im. 1 Sat..		8 26 or	13^h 49′ MT. (29)
	104 ——	6.7	1 30	13 24 N	31	Sun		18 43	23 6 S
	Saturn ...		4 1	18 37 N		Mercury..		20 7	21 25 S
30	Sun		18 38	23 10 S		Venus ...		21 24	17 10 S
	Mercury..		20 2	21 48 S		48 ε Ariet.	5	2 49	20 38 N
	Venus ...		21 19	17 33 S		Moon....		2 57	20 7 N
	Im. *	7	23 0 or	4^h 21′ MT.		58 ζ Ariet.	5	3 5	20 23 N
	*'s R.A. 2^h 0′ Decl. 16° 24′ N. (13′N.)					61 τ 1——.	6	3 11	20 31 N
	Em. * ...		23 46 or	5^h 10′ MT. (4′N.)		Im. * 1...	7	3 21 or	8^h 40′ MT.
	8 ι Arietis	6	1 48	16 58 N		*'s R.A. 2^h 59′ Decl. 20° 5′ N. (4′S.)			
	I. 243..	6	1 54	17 25 N		Saturn ...		4 0	18 36 N
	I. 257....	8	1 58	17 12 N		Em. * 1..		4 21 or	9^h 40′ MT. (11′S)
	Moon....		2 5	16 41 N		Im. * 2...	5	6 36 or	11^h 54′ MT.
	Saturn ...		4 1	18 36 N		*'s R.A. 3^h 5′ Decl. 20° 23′ N. (4′S.)			
	Im. 2 Sat..		4 48 or	10^h 11′ MT. (29)		Em. * ...		7 32 or	12^h 50′ MT. (9′S.)

Art. VII. *On the Boiling Points of Saturated Solutions.* *By* T. Griffiths.

To examine and determine the boiling points of saturated solutions, and the quantity of salt dissolved at their respective temperatures, with the view, if possible, of furnishing a useful and interesting table, has been the object of the present series of experiments.

Of the great number of saline bodies, the most important only have been selected; and of them perhaps comparatively few, many others being so exceedingly soluble, and changing their composition by the application of heat, that they have necessarily been excluded from these experiments The method adopted in ascertaining the temperature consisted in exposing water with great excess of salt, in barrel-shaped porcelain vessels to the heat of an argand lamp, a thermometer being exactly placed in the centre of the liquid. When the solution was in full ebullition, the degree indicated by the thermometer was carefully taken, the barometer on the days the experiments were made, being at 30 inches.

In the following Table the first column contains the name of the

salt, the second shows the quantity of dry salt in 100 parts of the boiling solution, and in the third is given its boiling point.

Name of Salt.	Dry Salt in 100 Parts.	Boiling Point.
Acetate of Soda	60	256°
Nitrate of Soda	60	246
Rochelle Salt	90	240
Nitrate of Potassa	74	238
Muriate of Ammonia	50	236
Sulphate of Nickel	65	235
Tartarate of Potassa	68	234
Muriate of Soda	30	224
Nitrate of Strontia	53	224
Sulphate of Magnesia	57.5	222
Super Sulphate of Potassa	not determined	222
Borax	52.5	222
Phosphate of Soda	not determined	222
Sub carb. of Soda	not determined	220
Muriate of Baryta	45	220
Sulphate of Zinc	45	220
Alum	52	220
Oxalate of Potassa	40	220
Oxalate of Ammonia	29	218
Prussiate of Potassa	55	218
Chlorate of Potassa	40	218
Boracic acid	not determined	218
Sulphate Potassa and Copper	40	217
Sulphate of Copper	45	216
Sulphate of Iron	64	216
Nitrate of Lead	52.5	216
Acetate of Lead	41.5	215
Sulphate of Potassa	17.5	215
Nitrate of Baryta	26.5	214
Bi-Tartarate of Potassa	9.5	214
Acetate of Copper	16.5	214
Prussiate of Mercury	35	214
Corrosive Sublimate	not determined	214
Sulphate of Soda	31.5	213

The quantities expressed in the second column were ascertained by weighing out a portion of the boiling solution, and after expelling its water by heat, taking the weight of the dry salt that remained. In this manner it was expected that very soluble salts would yield the greatest quantity of dry salt, and the highest boiling points. But in many instances this is not the case, and remarkably so with sulphate of soda, its solution containing only 31.5 per cent., and elevating the boiling point of water but one degree *. The elevation of temperature does not seem to depend upon the quantity of salt present, or its solubility. Tartarate of Potassa, a salt very deliquescent, 68 parts of which are contained in 100 parts of the solution, boils at 234°, whilst Mur. Ammonia, a salt unchanged by exposure to air, of which but 50 per cent. is contained in its solution, boils at 236°, a solution containing ninety per cent. of Rochelle salt boils at 240°, whilst one of Acetate of Soda containing only 60 per cent. of the salt boils at 256°. Solutions of Prussiate of Mercury and Bi-Tartarate of Potassa boil precisely at the same temperature, but the former containing 35 per cent. of dry salt, the latter only 9.5.

The boiling points of the following solutions have not been accurately determined, on account of the great difficulty of making saturated solutions, but the numbers are probably very nearly correct.

Pure Soda . . .	420°	Solution corroding the thermometer's bulb
Nitrate of Ammonia	360	
Nitrate of Copper	344	
Caustic Potash .	316	increasing rapidly by continuation of heat.
Oxalic Acid . .	234	increasing and subliming at 250

A curious circumstance happens when a solution of Carb. Ammonia is exposed to heat; it seems to boil at 180°, and if the temperature be increased the salt evaporates, and by the time the water reaches its boiling point, it is perfectly free from all traces of the substance.

* In experimenting with this substance the crystals of the salt were liquefied by heat, and boiled in their water of crystallization.

ART. VIII. *On Fumigation. By* M. Faraday, F.R.S., Corr. Mem. Acad. Sciences, Paris, Chem. Assist. Royal Institution, *&c.*

I WAS called on some months since to direct and superintend the fumigation of the general Penitentiary at Milbank, in doing which some precautions and arrangements suggested themselves, which I have thought might be usefully made known for the information of those who may have occasion to apply disinfecting agents to the purification of buildings, either large or small.

On examining a building to be fumigated, it is necessary to estimate the surface exposed to the infectious vapours, as well as the capacity of the structure. When the air of a place is impregnated with infectious matter, the surface of the walls, *&c.*, will absorb more or less of it in proportion as it is more or less extensive, as it approaches nearer to or is farther from the source of infection, and also in some degree according to its nature.

The general arrangement of the Penitentiary was favourable to its complete and perfect fumigation; for, though of great magnitude, yet its division into smaller parts as galleries, towers, staircases, *&c.*, most of which were glazed, and all of which could be closed by doors so as to separate them from each other, rendered the successive application of the means employed easy and convenient.

After deciding upon fumigation by chlorine, the next object was to ascertain the most favourable mode of applying it; and I was desirous for many reasons of obtaining a gradual and successive developement of the disinfecting agent, rather than a sudden and short one. The latter mode, though it would have filled the building at once, and probably very effectually, yet would seriously have incommoded the operators, and would also soon have disappeared in consequence of absorption by the limed walls, and from dissipation through apertures that would inevitably remain unclosed in different parts of the building: whilst the former mode by continually

supplying the disinfecting agent to the atmosphere of the place for a length of time, would enable it better to act on the bedding, clothing, and other articles left in the cells, and allow it also more perfectly to penetrate to every part of the building itself.

The materials used were those generally employed, namely, common salt, oxide of manganese in powder, and oil of vitriol. Upon making experiments with these substances as furnished by the dealer for the fumigation, I found that a mixture of one part by weight of common salt and one part of the oxide of manganese, when acted upon by two parts of oil of vitriol previously mixed with one part (by weight) of water, and left till cold, produced the best results. Such a mixture made at temperatures of 60° Fahr. liberated no muriatic acid; but in a few minutes began to evolve chlorine, and continued to do so for four days. When examined on the fifth day, and urged by heat, so as to cause the liberation of all the chlorine that could be afforded by it, only a small proportion was obtained. Such a mixture may therefore be considered as having liberated its chlorine gradually but perfectly, without the application of any extraneous heat; and is therefore very proper for extensive fumigation.

The vessels in which the mixture is to be made should be flat, and such as, being economical, are least acted on by the chlorine or acid. Common red pans were used in the Penitentiary; for many being required at once, better earthen ware would have been too expensive. They held each about four quarts.

Preparatory to the fumigation a quantity of the salt was turned out, the lumps broken down by a mallet until the whole was in powder, and then an equal weight of the oxide of manganese added, and the whole well mixed. The acid and water were mixed in a wooden tub, the water being put in first, then about half the acid added, stirring at the same time. When the heat produced had been dissipated, which happened in a few hours, the rest of the acid was added, stirring as before, and the whole left till cold. The men used measures in mixing the acid and water, and were told to take rather less of water than of acid, 9 measures to 10 being nearly the quantities required. Any

slight departure from these proportions would be of no consequence. The pans were then charged, each with about $3\frac{1}{3}$lb. of the mixed salt and manganese, and distributed at proper intervals along the galleries, *&c.*, care having been taken previously to close the doors and windows, and to stop with mats or rugs all apertures to which access could be had, especially key-holes, through which there was any draft. The diluted acid being cold was then carried in cans or jugs, and measured out in the proportion of $4\frac{1}{2}$lb. to each pan, the mixture being well stirred with a stick, and left to itself. This was done without any inconvenience to the operator, except when the acid was applied too warm: there was abundant time to go from pan to pan, and to close the various galleries in succession. On entering a gallery a few minutes after it had been thus treated, the general diffusion of the chlorine in the atmosphere was sufficiently evident. In half an hour it was often almost impossible to enter, and frequently on looking along the gallery (150 feet in length), the yellow tint of the atmosphere could easily be perceived. Up to the fifth day the odour of the chlorine could generally be observed in the building. After the sixth the pans were removed, though sometimes with difficulty, to be emptied and used elsewhere; and the place fumigated, had its windows and doors thrown open.

It was estimated that the charge of each pan would yield about 1 lb. of chlorine, or $5\frac{1}{2}$ cubical feet. The whole quantity of materials used was 700 lb. of common salt, 700lb. oxide of manganese, and 1400 lb. of oil of vitriol. The space requiring fumigation amounted to nearly 2,000,000 cubical feet, and the surface of the walls, floors, ceilings, *&c.*, exclusive of furniture, bedding, *&c.*, was about 1,200,000 square feet. This surface was principally stone and brick, most of which had been lime-washed. The space was divided into 72 galleries of 150 feet each in length, and towers, passages, chapel, *&c.*, equivalent to about 13 galleries more. The number of cells, rooms, *&c.*, was nearly 1200.

It was desirable for many reasons that the Penitentiary should

be fumigated in the most unexceptionable manner, and the means employed were therefore applied to an extent probably far beyond that requisite to the destruction of any miasmata that might be within it. The proportion of chlorine evolved to the size and surface of the building may be considered therefore as sufficient for a case of the most excessive kind; and, though the limits are guessed at rather than judged of by any well-founded rule, yet I should consider from one-half to one-fourth of the chlorine as quite sufficient for any of the usual cases where fumigation is required.

ART. IX. *On the General Nature and Advantages of Wheels and Springs for Carriages, the Draft of Cattle, and the Form of Roads. By* Davies Gilbert, Esq. F.R.S., *&c.*

TAKING wheels completely in the abstract, they must be considered as answering two different purposes.

First, they transfer the friction which would take place between a sliding body and the comparatively rough uneven surface over which it slides, to the smooth oiled peripheries of the axis and box, where the absolute quantity of the friction as opposing resistance is also diminished by leverage, in the proportion of the wheel to that of the axis.

Secondly, they procure mechanical advantage for overcoming obstacles in proportion to the square roots of their diameters when the obstacles are relatively small, by increasing the time in that ratio, during which the wheel ascends: and they pass over small transverse ruts, hollows, or pits, with an absolute advantage of not sinking, proportionate to their diameters, and with a mechanical one as before, proportionate to the square roots of their diameters.

Consequently, wheels thus considered cannot be too large: in practice, however, they are limited by weight, by expense, and by convenience.

With reference to the preservation of roads, wheels should be

made wide, and so constructed as to allow of the whole breadth bearing at once; and every portion in contact with the ground should roll on it without the least dragging or slide: but, it is evident from the well-known properties of the cycloid, that the above conditions cannot unite unless the roads are perfectly hard, smooth, and flat; and, unless the fellies of the wheels, with their tires, are accurately portions of a cylinder. These forms, therefore, of roads and of wheels are the models towards which they should always approximate.

Roads were heretofore made with a transverse curvature to throw off water, and in that case it seems evident that the peripheries of the wheels should in their transverse sections become tangents to this curve, from whence arose the necessity for dishing wheels, and for bending the axes; which contrivances gave some incidental advantage for turning, for protecting the nave, and by affording room for increased stowage above. But recent experience having proved that the curved form of roads is wholly inadequate for obtaining the end proposed, since the smallest rut intercepts the lateral flow of the water; and, that the barrel-shape confines carriages to the middle of the way, and thereby occasions these very ruts,—roads are now laid flat, carriages drive indifferently over every part, the wear is uniform, and not even the appearance of a longitudinal furrow is to be seen. It may, therefore, confidentially be hoped that wheels approaching to the cylindrical form will soon find their way into general use.

The line of traction is mechanically best disposed when it lies exactly parallel to the direction of motion, and its power is diminished at any inclination of that line in the propo rtions of the cosine of the angle to radius. When obstacles frequently occur, it had better perhaps receive a small inclination upwards, for the purpose of acting with most advantage when those are to be overcome. But it is probable that different animals exert their strengths most advantageously in different directions, and therefore practice alone can determine what precise inclination of this line is best adapted to horses, and what to oxen. These considerations are, however, only applicable to cattle drawing imme-

diately at the carriage; and the convenience of this draft as connected with the insertion of the line of traction, which continued ought to pass through the axis of the wheels, introduces another limit to their size.

Springs were in all likelihood applied at first to carriages, with no other view than to accommodate travellers. They have since been found to answer several important ends.

They convert all percussion into mere increase of pressure—that is, the collision of two hard bodies is changed by the interposition of one that is elastic, into a mere accession of weight. Thus the carriage is preserved from injury, and the materials of the road are not broken: and, in surmounting obstacles, instead of the whole carriage with its load being lifted over, the springs allow the wheels to rise, while the weights suspended upon them are scarcely moved from their horizontal level. So that, if the whole of the weight could be supported on the springs, and all the other parts supposed to be devoid of inertia, while the springs themselves were very long, and extremely flexible, this consequence would clearly follow, however much it may wear the appearance of a paradox; that such a carriage may be drawn over a road abounding in small obstacles without agitation, and without any material addition being made to the moving power or draft. It seems, therefore, probable that, under certain modifications of form and material, springs may be applied with advantage to the very heaviest waggons; and consequently, if any fiscal regulations exist either in regard to the public revenue or to local taxation, tending to discourage the use of springs, they should forthwith be removed.

Although the smoothness of roads and the application of springs are beneficial to all carriages and to all rates of travelling, yet they are eminently so in cases of swift conveyance, since obstacles when springs are not interposed, require an additional force to surmount them beyond the regular draft, equal to the weight of the load multiplied by the sine of the angle intercepted on the periphery of the wheel between the points in contact with th ground and with the obstacle, and therefore proportionate to the

square of its height; and a still further force, many times greater than the former when the velocity is considerable, to overcome the inertia, and this increases with the height of the obstacle, and with the rapidity of the motion, both squared. But, when springs are used, this latter part, by far the most important, almost entirely disappears, and their beneficial effects in obviating the injuries of percussion are proportionate also to the velocities squared.

The advantages consequent to the draft from suspending heavy baggage on the springs, were first generally perceived about 40 years since on the introduction of mail-coaches; then baskets and boots were removed, and their contents were heaped on the top of the carriage. The accidental circumstance, however, of the height being thus placed at a considerable elevation, gave occasion to a prejudice, the cause of innumerable accidents, and which has not, up to the present time, entirely lost its influence; yet, a moment's consideration must be sufficient to convince any one, that when the body of a carriage is attached to certain given points, no other effect can possibly be produced by raising or by depressing the weights within it, than to create a greater or a less tendency to overturn.

The extensive use of waggons suspended on springs, for conveying heavy articles, introduced within these two or three last years, will form an epoch in the history of internal land communication, not much inferior perhaps in importance to that when mail-coaches were first adopted; and the extension of vans in so short a time to places the most remote from the metropolis, induces a hope and expectation, that as roads improve the means of preserving them will improve also, possibly in an equal degree, so that permanence and consequent cheapness, in addition to facility of conveyance, will be distinguished features of the M'Adam system.

Art. X. ASTRONOMICAL AND NAUTICAL COLLECTIONS.

No. XIX.

i. *A Method of finding the Latitude at Sea, by the Altitudes of two fixed Stars when on the same Vertical.* By C. Blackburn, Esq., of the Royal Naval College, Portsmouth.

Let the *corrected altitude, polar* and *zenith distances* of that heavenly body which has the *greater* altitude, be denoted by A, P, Z; and the corresponding quantities belonging to that heavenly body which has the *less* altitude be denoted by a, p, z. Let $A - a$ be called I; and $P + I$ be called S; then

Rule.

Add together the five following logarithms, *viz.*, the l. cosec. I; the l. cosin. A; the l. sin. $\frac{1}{2}\,\overline{S+p}$; the l. sin. $\frac{1}{2}\,\overline{S-p}$, and the constant logarithm 0.301030; and reject 30 from the index.

Subtract the natural number* belonging to this logarithm from the nat. cosin. $\overline{P \backsim Z}$; the remainder will be the nat. sine of the true latitude.

Demonstration.

Let the figure represent a projection of the hemisphere upon the plane of the meridian; Z the zenith, P the pole; HO the horizon; S, s, two places of the same, or different heavenly bodies on the same vertical Zs; PS and Ps meridians; then by the principles of spherical trigonometry,

$$\cos.^2 \tfrac{1}{2}\, PSs = \frac{R^2 \times \sin. \frac{1}{2}(PS + Ss + Ps) \times \sin. \frac{1}{2}(PS + Ss - Ps)}{\sin. PS \times \sin. Ss}$$

$$\text{or } \sin.^2 \tfrac{1}{2}\, ZSP = \frac{R^2 \times \sin. \frac{1}{2}(S + p) \times \sin. \frac{1}{2}(S - p)}{\sin. P \times \sin. I}$$

Again, $\cos. ZP = \cos. (PS \backsim ZS) - \sin. PS \times \sin. ZS \times \sin.^2 \frac{1}{2}$ $ZSP \times \frac{2}{R^3}$

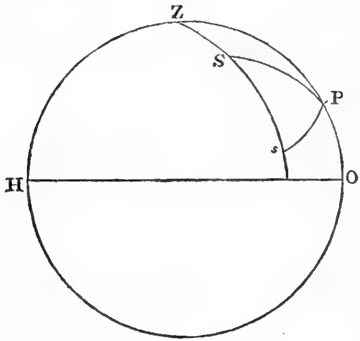
* If the index of the logarithm be 9, find the natural number to as many places as the Tables are calculated to: if the index be 8, to one less, and so on.

or sin. OP . $=$ cos. (P $\backsim$ Z) $-$ sin. P $\times$ sin. Z $\times$ sin.$^2\frac{1}{2}$ZSP $\times \frac{2}{R^3}$

Therefore by substituting in this latter equation, the former value of sin.$^2\frac{1}{2}$ ZSP, we get,

$$\text{sin. OP} = \text{cos.}(P \backsim Z) - \frac{\text{sin.}P \times \text{sin.}Z \times \text{sin.}\frac{1}{2}(S+p) \times \text{sin.}\frac{1}{2}(S-p) \times 2}{\text{sin. P} \times \text{sin. I} \times R}$$

or sin. Lat. $=$ cos. (P $\backsim$ Z) $-$ cosec. I $\times$ cos. A $\times$ sin. $\frac{1}{2}(S+p)$ $\times$ sin. $\frac{1}{2}(S-p) \times \frac{2}{R^3}$, which is the same as the rule.



Example I.

January 30, 1825, in N. latitude, let the altitudes of Capella and Castor when on the same vertical be respectively 48° and 17° 45′. Required the latitude.

l. cosec. I $=$	0.297764	P $=$	44°	11′	17″
l. cosin. A $=$	9.825511	I $=$	30	15	0
l. sin.$\frac{1}{2}.\overline{S+p}=$	9.961028	S $=$	74	26	17
l. sin.$\frac{1}{2}.\overline{S-p}=$	9.162025	p $=$	57	44	17
const. log. $=$	0.301030		132	10	34
N $=$ 352663	9.547358		16	42	0
n. cos. $\overline{P \backsim Z}$ $=$	999271	$\frac{1}{2}.\overline{S+p}=$	66	5	17
$-$ N $=$	352663	$\frac{1}{2}.\overline{S-p}=$	8	21	0
Lat. 40° 17′ 11″	646608 $=$ n. s.				

Example II.

January 1, 1825, in N. latitude, let the altitudes of Capella and Ursæ Majoris, when on the same vertical, be respectively 70° 15′ and 11° 30′. Required the latitude.

			°	′	″
l. cosec. I =	0.063569	I =	59	45	0
l. cosin. A =	9.528810	P =	44	11	20
l. sin. $\frac{1}{2}\ \overline{S+p}$ =	9.971969	S =	103	56	20
l. sin. $\frac{1}{2}\ \overline{S-p}$ =	9.750951	p =	35	19	55
const. log. =	0.301030		139	16	15
N 413361	9.616329		68	36	25
n. cos. $\overline{P \backsim Z}$	910403	$\frac{1}{2}.\overline{S+p}$ =	69	38	7.5
− N =	413361	$\frac{1}{2}.\overline{S-p}$ =	34	18	12.5
Lat. = 29° 48′ 13″	497042 = n. s.				

It is easy for a correct eye to determine when a line passing through two stars is *nearly* perpendicular to the horizon; and in that part of the heavens towards the elevated pole, when this line inclines a little to the right of the perpendicular, the stars will shortly afterwards be on the same vertical.

To take the altitudes, let the observer turn towards the elevated pole, and select any two stars, not very near to each other, which have nearly arrived at their vertical position. Let successive pairs of altitudes be taken, till the stars have just passed the perpendicular, and the differences be noted. These differences will gradually increase till they attain a maximum, and afterwards decrease. That pair of altitudes, the difference between which is the greatest, is the pair to be made use of in the calculation, for the instant at which the difference between the altitudes is greatest, is the instant of their being on the same vertical.

And since the apparent angular distance of the two stars at that instant is always equal to the difference of their apparent altitudes; if these distances be taken at the same time with the altitudes, they will afford a constant check upon the observations; for the least of

the apparent distances should always correspond with the greatest difference of the apparent altitudes.

The quantity Ss, or I, will not be affected by the errors of dip, or terrestrial refraction: and may be obtained either by taking the difference of the corrected altitudes, or by increasing the least of the apparent distances by the difference of the refractions at the two altitudes.

The rule is applicable to stars on the same vertical, wherever situated; but in practice, it will be found convenient to take them in that part of the heavens towards the elevated pole, because the observations may then be made with greater expedition, and it may then be readily determined, which stars are about to appear on the same vertical.

This method is not embarrassed by distinctions of cases, and requires only the common tables.

ii. *A Rule for finding the Latitude by two altitudes of the Sun, or of a fixed Star, and the time elapsed between the Observations.*

The Rule is divided into two parts; the first part to be used when the latitude and declination are of *different* names, and the second when they are of the *same* name.

The letters A, *a*, denote respectively the greater and less altitudes; D, *d*, the declinations at those altitudes, D′ the mean declination, and E the elapsed time.

The azimuths are of the same name with the latitude.

The elapsed time is supposed less than twelve hours.

In finding the natural number to a logarithm, if the index be 9, find the number to as many places as the tables are calculated to; if the index be 8, to one less, and so on.

Rule I.

To be used when the latitude and declination are of *different* names.

1. Add together the log. cosin. D′, the log. sin. $\frac{1}{2}$. E, and reject 10 from the index; look for the remainder among the log. sines; twice the corresponding arc, will be arc I.

2. Add together; the log. sin. E; the log. cos. d; the log. cosec. I, and reject 20 from the index; look for the remainder among the log. sines; *half the supplement* of the corresponding arc will be arc II.

3. Let A + I be called S; then add together the log. cosec. I; the log. secant. A; the log. cosin. $\frac{1}{2}\overline{S+a}$; the log. sin. $\frac{1}{2} . \overline{S-a}$, and reject 20 from the index; half the remainder will be the log. sine of arc III.

4. The *difference* of the second and third arcs will be arc. IV.

5. Add together the log. cosin. A; the log. cosin, D; twice the log. sin. IV; the constant logarithm 0.301030, and reject 30 from the index; subtract the natural number belonging to this logarithm from the nat. cosin. $\overline{A + D}$; the remainder will be the nat. sine of the true latitude.

This Rule requires no distinction of cases.

Rule II.

To be used when the latitude and declination are of the *same* name.

1. Add together the log. cosin. D′, the log. sin. $\frac{1}{2}$ E; and reject ten from the index, look for the remainder among the log. sines; *twice* the corresponding arc will be arc I.

2. Add together the log. sin. E; the log. cosin. d; the log cosec. I, and reject 20 from the index; look for the remainder among the log. sines; *half* the corresponding arc will be arc II.

3. Let A+I be called S; then add together the log. cosec. I, the log. secant A; the log. cosin. $\frac{1}{2} . \overline{S+a}$; the log. sin. $\frac{1}{2}\overline{S-a}$, and reject 20 from the index; *half* the remainder will be the log. sin. arc III.

4. The *sum* or *difference* between the second and third arcs will be arc IV. (a)

5. Add together the log. cosine A; the log. cosin. D; twice the log. sin. IV.; the constant logarithm 0.301030, and reject 30 from the index; subtract the natural number belonging to this logarithm

from the nat. cosine $\overline{A - D}$; the remainder will be the nat. sine of the true latitude.

(*a*) 1. When the observations are both on the *same* side of the meridian, and the azimuth at the *greater* altitude is *less* than the other azimuth, then the fourth arc is equal to the *sum* of the second and third arcs.

2. Also, when the first observation is taken in the forenoon, and the second in the afternoon, and the *sum* of the azimuths is *less* than 180°, the fourth arc is equal to the *sum* of the second and third arcs.

3. In *all other cases* the fourth arc is equal to the *difference* of the second and third arcs.

The Rules when used as here directed, will *in every case* give the latitude without ambiguity, and with sufficient accuracy, for the purposes of navigation. In fact, when the common tables are used, the difference between the true arc Ss or I, and that determined by using the mean declination, will not, in general, be detected. In *practice*, therefore, the latitude as determined by this method will seldom differ from that which would have been obtained, if the first arc had been computed by the most exact method. The demonstration of the rules is not given, as they are merely an attempt to simplify the common method, and to facilitate the distinction of the cases. In taking the altitudes, whether on the same or on different sides of the meridian, the observer should make the *difference* between them as great as may be, without approaching very near either to the horizon or to the meridian. The elapsed time, therefore, should not at any time exceed eight hours.

Example I.

March 1, 1824, in N. latitude, at $1^h\ 20^m$ P.M., the true altitude of the sun's centre was $47°\ 50'$; at $4^h\ 40^m$ the same afternoon his altitude was $13°\ 40'$, the mean declination being $7°\ 26'$. Required the latitude.

To find arc I.

l. cosin. D'	=	9.996335
l. sin. $\frac{1}{2}$ E	=	9.625948
24° 46′ 32″		9.622283 l. s.
I = 49 33 4		

To find arc II.

l. sin. E	=	9.884254
l. cos. d	=	9.996362
l. cosec. I	=	0.118625
93 23 0		9.999241 l. s.
II = 46 41 30		

To find arc III.

l. cosec. I	=	0.118625
l. secant A	=	0.173090
l. cosin. $\frac{1}{2}.\overline{S+a}$	=	9.752846
l. sin. $\frac{1}{2}.\overline{S-a}$	=	9.824320
		19.868881
III. 59 18 13		9.934440 l. s.
II. 46 41 30		
IV. = 12 36 43		

To find arc V.

l. cosin. A	=	9.826910
l. cosin. D	=	9.996308
2. l. sin. IV	=	8.678294
constant log.		0.301030
N = 63466		8.802542
nat. cos. $\overline{A+D}$	=	569375
− N	=	63466
Lat = 30° 23′ 54″		505909 n.s.

	°	′	″
I =	49	33	4
A =	47	50	0
S =	97	23	4
a =	13	40	0
	111	3	4
	83	43	4
$\frac{1}{2}.\overline{S+a}$	55	31	32
$\frac{1}{2}.\overline{S-a}$ =	41	51	32

In this example the latitude and declination are of *differen* names; therefore no distinction of case is necessary by Rule I.

Example II.

June 14, 1824, in N. latitude, at $7^h\ 30^m$ A.M., the sun's altitude and azimuth were 27° and 73°; at $9^h\ 30^m$ the same forenoon, his altitude and azimuth 54° 10′ and 78°, the mean declination being 23° 17′. Required the latitude.

To find arc I.

	l. cos. D′ =	9.963108
	l. sin. ½ E =	9.412996
	13° 45′ 12″	9.376104 l. s.
I = 27 30 24		

To find arc II.

	l. sin. E =	9.698970
	l. cos. d =	9.963101
	l. cosec I =	0.335497
	83 56 32	9.997568 l. s.
II = 41 58 16		

To find arc III.

	l. cosec. I =	0.335497
	l. sec. A =	0.232525
	l. cos. $\frac{1}{2}\ \overline{S+a}$ =	9.765685
	l. sin. $\frac{1}{2}\ \overline{S-a}$ =	9.662019
		19.995726
III = 84° 19′ 15″		9.997863 l. s.
II = 41 58 16		
IV = 42 20 59		

To find arc V.

l. cos. A =	9.767475
l. cos. D =	9.963115
2 . l. sin. IV =	9.656874
const. log. =	0.301030
N = 488083	9 688494
n. cos. $\overline{A-D}$ =	858194
− N =	488083
Lat. = 21° 43′ 20″	370111 n.s.

	°	′	″
I =	27	30	24
A =	54	10	0
S =	81	40	24
a =	27	0	0
	108	40	24
	54	40	24
$\frac{1}{2}\ .\ \overline{S+a}$ =	54	20	12
$\frac{1}{2}\ .\ \overline{S-a}$ =	27	20	12

In this Example, the azimuth at the greater altitude is greater than the other azimuth; therefore the fourth arc is equal to the *difference* of the second and third arcs, by Rule II.

Example III.

July 1, 1824, in N. latitude, at 9^h P.M., the true altitude of the sun's centre was 13° 30′; and on July 2, at 2^h 32^m A.M. his altitude was 11°; required the latitude, the mean declination being 23° 5′.

To find arc I.

$$
\begin{array}{lrl}
\text{l. cos. } D' & = & 9.963757 \\
\text{l. sin. } \tfrac{1}{2}\,E & = & 9.821265 \\
37^\circ\,33'\,30'' & & 9.785022 \text{ l. s.} \\
I = 75\;\;7\;\;0 & &
\end{array}
$$

To find arc II.

$$
\begin{array}{lrl}
\text{l. sin. } E & = & 9.996751 \\
\text{l. cos. } D & = & 9.963782 \\
\text{l. cosic. } I & = & 0.014820 \\
70^\circ\,52'\,44'' & & 9.975353 \text{ l. s.} \\
II = 35\;\;26\;\;22 & &
\end{array}
$$

To find arc III.

$$
\begin{array}{lrl}
\text{l. cosec. } I & = & 0.014820 \\
\text{l. sec. } A & = & 0.012168 \\
\text{l. cos. } \tfrac{1}{2}.\overline{S+a} & = & 9.809793 \\
\text{l. sin. } \tfrac{1}{2}.\overline{S-a} & = & 9.797071 \\
 & 2) & 19.633852 \\
III = 40^\circ\,59'\,53'' & & 9.816926 \text{ l. s.} \\
II = 35\;\;26\;\;22 & & \\
IV = \;\;5\;\;33\;\;31 & &
\end{array}
$$

To find arc V.

$$
\begin{array}{lrl}
\text{l. cos. } A & = & 9.987832 \\
\text{l. cos. } D & = & 9.963732 \\
2.\text{l. sin. } IV & = & 7.972322 \\
\text{const. log.} & = & 0.301030 \\
N = 16785 & & 8.224916 \\
\text{n. cos. } \overline{A - D} & = & 986021 \\
- N & & 16785 \\
\text{Lat.} = 75^\circ\,45'\,4'' & & 969236 \text{ n.s}
\end{array}
$$

$$
\begin{array}{rrrrr}
I & = & 75 & 7 & 0 \\
A & = & 13 & 30 & 0 \\
S & = & 88 & 37 & 0 \\
a & = & 11 & 0 & 0 \\
 & & 99 & 37 & 0 \\
 & & 77 & 37 & 0 \\
\tfrac{1}{2}.\overline{S+a} & = & 49 & 48 & 30 \\
\tfrac{1}{2}.\overline{S-a} & = & 38 & 48 & 30
\end{array}
$$

In this example the first observation is taken in the afternoon, and the second in the forenoon; therefore the fourth arc is equal to the *difference* of the second and third arcs, by Rule II.

Example IV.

July 6, in N. latitude at 11^h, A.M., the true altitude of the sun's centre was 74°, and his azimuth 63°; at $5^h\ 40^m$ P.M. his altitude was 10° 30′, and his azimuth 70°, the mean declination being 22° 41′; required the latitude.

To find arc I.

l. cos. D'	= 9.965037	
l. sin. $\frac{1}{2}$ E	= 9.884254	
44° 58′ 28″	9.849291	l. s.
I = 89 56 56		

To find arc II

l. sin. E	= 9.993351	
l. cos. d	= 9.965080	
l. cosec. I	= 0.000000	
65° 19′ 45″	9.958431	l. s.
II = 32 39 52		

To find arc III.

l. cosec. I	= 0.000000	
l. sec. A	= 0.559662	
l. cos. $\frac{1}{2}\overline{S+a}$	= 8.685056	
l. sin. $\frac{1}{2}\overline{S-a}$	= 9.988237	
	2) 19.232955	
III = 24° 25′ 30″	9.616474	l. s.
II = 32 39 52		
IV = 57 5 22		

To find arc V.

l. cos. A	= 9.440338	
l. cos. D	= 9.964994	
2 . l. sin. IV	= 9.848062	
const. log.	0.301030	
N = 358446	9.555424	
n. cos. $\overline{A-D}$ =	625200	
− N =	358446	
Lat. = 15° 28′ 16	266754	n.s.

	°	′	″
I =	89	56	55
A =	74	0	0
S =	163	56	56
a =	10	30	0
	174	26	56
	153	26	56
$\frac{1}{2}\,.\,\overline{S+a}$ =	87	13	28
$\frac{1}{2}\,.\,\overline{S-a}$ =	76	43	28

In this example the first observation is taken in the forenoon, and the second in the afternoon; and the sum of the azimuths is *less* than 180°, therefore the fourth arc is equal to the *sum* of the second and third arcs, by Rule II.

In applying the Rule to successive altitudes of the same *fixed star*, the interval between the observations must be measured by a sidereal chronometer. Or, if this be not at hand, the interval measured by a common chronometer may be increased at the rate of 2′ 28″ for every 15°.

The following directions will distinguish all the cases.

1. When the observations are both on the same side of the meridian, and the azimuth at the greater altitude is less than the other azimuth, the fourth arc is equal to the *sum* of the second and third arcs.

2. When the first observation is taken on the E side of the meridian, and the second on the W side, and the *sum* of the azimuths is at the same time *less* than 180°, then also the fourth arc is equal to the *sum* of the second and third arcs.

3. In *all other* cases, the fourth arc is the *difference* of the second and third arcs.

EXAMPLE V.

December 6, 1824, in N. latitude, let the altitude and azimuth of Regulus be respectively 12° 30′, and 83°; four hours afterwards when on the same side of the meridian, let his altitude and azimuth be 56° and 132°. Required the latitude.

To find arc I.

l. cos. D = 9.989051
l. sin. $\frac{1}{2}$ E = 9.698970
29° 10′ 47″ 9.688021 l. s.
I = 58 21 34

To find arc II.

l. sin. E = 9.937531
l. cos. D = 9.989051
l. cosec. I = 0.069890
82° 42′ 25″ 9.996472 l. s.
II = 41 21 12

To find arc III.

l. cosec. I = 0.069890
l. sec. A = 0.252438
l. cos. $\frac{1}{2}\,\overline{S+a}$ = 9.650594
l. sin. $\frac{1}{2}\,\overline{S-a}$ = 9.890070
2) 19.862992
III = 58° 39′ 28″ 9.931496 l. s.
II = 41 21 12
IV = 17 18 16

To find arc V.

l. cos. A = 9.747562
l. cos. D = 9.989051
2 . l. sin. IV = 8.946824
const. log. = 0.301030
N = 96487 8.984467
n. cos. $\overline{A-D}$ = 729108
— N = 96487
Lat. = 39 14′ 38″ 632621 n.s.

	°	′	″
I =	58	21	34
A =	56	0	0
S =	114	21	34
a =	12	30	0
	126	51	34
	101	51	34
$\frac{1}{2}\,.\,\overline{S+a}$ =	63	25	47
$\frac{1}{2}\,.\,\overline{S-a}$ =	50	55	47

In this example the azimuth at the greater altitude is greater than the other azimuth; therefore the fourth arc is equal to the *difference* of the second and third arcs, by Rule II.

From a review of these Rules and Examples it may, perhaps, be said that the *direct* method of finding the latitude by two altitudes of the same heavenly body, and the time between the observations, frequently considered useless to seamen, from the length of the operation, or from the difficulty of distinguishing the cases, is, when thus stated, but little more troublesome than the *indirect* method of Douwes; for *one* operation will always give the latitude. And with respect to the cases, when the latitude and declination are of different names, they require no distinction; and the nature of the others is known at once from the azimuths, which it is necessary to observe with no greater accuracy than to determine whether one of them be greater than the other, or whether their sum be greater or less than 180.

Art IX. ANALYSIS OF SCIENTIFIC BOOKS.

I. *Practical Observations on Hydrophobia, with a Review of the Remedies employed, and Suggestions for a different Treatment of that Disease. By* John Booth, M.D., *one of the Physicians to the Birmingham General Hospital,* &c. &c.

So many cases of hydrophobia, and all, with one *very* doubtful exception, of fatal termination, have lately occurred in and about the metropolis, that we think it right to use our humble endeavours to draw attention to the subject, with a view of pointing out the most effectual preventive means to be employed, and of inquiring how far any of the hitherto-proposed remedies are deserving of confidence. This we are happy to do through the medium of Dr. Booth's very unpretending pamphlet.

It appears from a variety of evidence, that the complete excision of the bitten part, provided it be performed before absorption has taken place, is an effectual preventive of the accession of the disease; but practitioners seem by no means to have made up their minds as to the extent of delay which in such cases may take place, and many lives have been sacrificed to this uncertainty; indeed, it appears that the entire and immediate removal of the bitten parts affords the ONLY ground of perfect security. But as this, from a variety of causes, is not always attainable, it becomes a question how far caustic applications of any kind can be depended on. Although we agree with our author, that if excision has been effectually accomplished the application of caustic is not only unnecessary but also mischievous, we apprehend that in cases of slight and superficial wounds from the teeth of a rabid animal, *some kinds of caustic* may prove as effectual as excision, and the caustic which we would particularly recommend is the *nitric acid;* the fluidity of which would enable it to penetrate into the wounds, while its extreme energy of action on animal substances would probably be exerted in the decomposition of the poison itself. This we by no means recommend as a *substitute* for excision, but as a remedy which may possibly sometimes be within our reach, where the skilful and proper cutting out of the part cannot be immediately resorted to.

Whenever these certain means of relief are neglected, and the disease unhappily has proceeded to develop itself, it becomes a question whether any, and what, remedies should be resorted to. In the treatment of hydrophobia there are four principles or plans upon which physicians seem to have proceeded.

1. That of stimulating and supporting the vital power, so as to enable it to obtain a triumph in the severe conflict to which it is exposed.

2. That of suddenly exhausting the system by large bleedings and purgatives, as believing the disease to be of a highly inflammable character.

3. That of opposing the poison by the usual antidotes or specifics, to which other animal poisons were supposed to yield.

4. That of regarding the disease as a nervous or spasmodic, instead of an inflammatory, affection, and consequently, as most successfully to be attacked by an antispasmodic course of medicines and regimen.

1. To the intention of stimulating and supporting the vital power, the very popular use of *volatile alkali* and *camphor* may be ascribed. To the same class of medicines, designed expressly to support the vital power and enable nature herself to triumph in so severe a struggle, belong also the warm and cordial *confections* and *theriacas* that were at one time in almost universal estimation; as also various kinds of *pepper* given in great abundance, *oil of cajeput*, different preparations of *tin*, *copper*, and *iron*, and in later periods *bark*.

2. In direct opposition to this stimulating and tonic plan, was that of suddenly debilitating and exhausting the system, on the hypothesis that the symptoms of canine rabies were those of violent and rapid inflammation.

To this view of the subject belongs the exhausting practice of violent and long *sub-mersion in cold water;* the patient in some cases having been thrown instantly and without warning into the water, and allowed to take his chance, and in other cases forcibly plunged under the water, and harassed with repeated submersions, until life itself became all but extinct. In connexion with the cold bath, thus persevered in, immersion in warm oil was an ancient adjuvant, and subsequently purgatives have sometimes, and at other times the lancet has been resorted to.

Bleeding has lately been revived, and carried to the extent of deliquium by large and repeated depletions, and the operation has been repeated almost as long as the powers of life would allow; but it is by no means certain, in the instances of success which have been reported to us, that the disease was genuine hydrophobia.

3. To counteract the poison of rabies by general or specific antidotes forms the next intention to which the practice in this disease may be referred. And from some supposed analogy of the canine virus to the poison of venemous animals, and particularly serpents, it has been opposed by the usual specifics and remedies, to which these are supposed to yield. The *radix mungo* is used in India as an antidote against the bite of the mad dog. Acids and alkalies belong to the same class of remedies. The general suffrage, however, is considerably in favour of *ammonia* or *volatile alkali.* There exists some analogical reasons for this preference. It is

well known that *ammonia* is a valuable medicine, whether applied externally or internally, in a variety of animal poisons. *Mercury* from its specific action on the salivary glands, the immediate outlet of the poison in rabies, has a strong claim to general attention, and has been very extensively tried in various forms, and not without acquiring a high degree of reputation. Its powers however as a specific are more than dubious.

Diuretics have also had their votaries. *Cantharides* were at one time the favourite medicine, applied topically or taken internally. The *lichen caninus* of Linnæus obtained the honour of a place in the *London Pharmacopœia* of 1721, under the title of *pulvis antilyssus*, of which it constituted the active principle, and the merits of the powder were extolled in the contemporary *Philosophical Transactions!!*

Emetics have not yet perhaps been sufficiently tried to enable us to determine the relative efficacy of this class of remedies in Hydrophobia. The case not long ago given by Dr. Satterley *, does not enable us to draw any distinct conclusion whatever on this head. Vomiting indeed occurred, and the patient swallowed cherry-brandy and water with little difficulty, but the disease seems to have been spurious, and the vomiting does not appear to have been excited by art.

4. In Hydrophobia, however, the nervous system appears to be that which is by far the most severely affected, and to which the disease may be most distinctly referred; hence, it is not to be wondered at that antispasmodics and sedatives should have been employed extensively and obtained a very general suffrage. In effect, whatever benefit in this disease has at any time been derived from *ammonia*, *camphor*, or *cold-bathing*, it is more easy to resolve their palliative or remedial powers into the principle of their being active antispasmodics, than into any other mode of action. The more direct antispasmodics and sedatives employed in this malady have been *musk*, *opium*, *belladonna*, *nux vomica*, and *stramonium*.

Musk and *opium* are the antispasmodics which have been chiefly depended upon. They have sometimes been given in very large doses alone, but more generally in unison with other remedies. With respect to *musk*, Cullen admits that Dr. Johnstone has given us two facts that are very much in favour of its power, and Gmelin regarded it as a specific antidote. *Opium* in like manner, when employed alone, has been given in large doses, and we have numerous cases on record, in which this, like the preceding medicines, is said to have operated a cure. But unfortunately neither *musk* nor *opium*, in whatever quantity employed, have been found hitherto successful in general practice. From the inefficiency of *opium* and *musk* separately, they have often been

* *Medical Transactions*, vol. iv.

united, to strengthen their effect; or either of them has been combined with *camphor, oil of amber,* inunction with *olive oil,* or *bleeding.*

Musk was also at one time very generally combined with *cinnabar,* and this combination was regarded as a specific, especially in the East, whence it was introduced into this country.

Arsenic has perhaps fairer pretensions than any of these. It has of late years been tried, and particularly, with great skill and in full doses, by Dr. Marcet; but, in every trial it has disappointed our hopes.

The *acetate of lead* has very recently been employed, according to the public journals, and, as it is reported, with success. In a case which partially came under his own observation, Dr. Booth tried that remedy, but it failed.

Hydrocyanic acid has occasionally been prescribed, but without any apparent benefit. In the form of the distilled water of the *prunus lauro-cerasus,* it was not long since made the subject of experiment at Paris by M. Dupuytren, who injected this fluid into the veins of various dogs; and, as it appears, in one instance, into those of a man; but in every case without effecting a cure.

Chlorine has also been strongly recommended on the authority of Professor Brugnatelli, who has adduced facts by which he considers the specific power of the *chlorine* to have been established and verified.

Some anomalous remedies, incapable of being ranged under any general head of Therapeutics, now remain to be noticed, as they have also acquired considerable celebrity in the cure of Hydrophobia.

The first of these is the *Ormskirk-medicine,* consisting, according to Dr. Black, who honoured it with an analysis, of powder of chalk, armenian-bole, alum, and elecampane root. This inert preparation enjoys still high local reputation as a specific in rabies. The second of the anomalous remedies is the *alysma plantago, madwort-plantain.* For some ages it has been a popular remedy for canine madness in the north of Europe.

The next remedy to be noticed is also of no mean authority. Whilst on the one hand medical practitioners are abstracting rabid blood from the system as the surest means of curing canine madness, the physicians of Finland have undertaken to accomplish the same effect by introducing blood into the system. A third variety of the process has more recently challenged general attention. M. Majendie has abstracted blood and introduced in lieu an equal quantity of tepid water into the morbid system; also with a certain degree of success. The plan, however, failed in the hands of Dr. Gaspard, as recently reported in the journals, who was induced to have recourse to it. It also proved inefficacious, as employed in a late case of Hydrophobia, occurring in Birmingham.

The last anomalous remedy now left for notice consists in the *extirpation of small knots or tumours*, said to be formed after a certain time under the tongue at the orifices of the sublingual gland, in which may be felt with a probe a fluctuating fluid—the hydrophobic poison! The patient is also to take for some time the decoction of *genista* *. This remedy constitutes the subject of a report, made to the Prussian Government, and published in the Berlin State Gazette!

This general summary of the remedies which have hitherto been in use will at least evince, that neither diligence nor enterprise can be deemed to have been wanting in the attempts of medical men to subdue this horrific disorder. And although truth should compel us to admit the futility of all previous curative attempts, no physician would feel that he fulfilled his duty by remaining a passive and inert spectator of the phenomena of the disease, whenever his aid might be required. But how is he to proceed? Shall he waste the precious time of action and almost the only time he can improve, in a vain recurrence to obsolete specifics, and abortive expedients?

"This," says our author, "is the important question I wish to raise, and the following suggestions, submitted with much deference, are meant to meet it, and to point out a new path of treatment, in which it may not be inexpedient to tread, although with caution.

"Let it be borne in mind that it is chiefly by the uncontrollable spasms of the muscles of respiration, and deglutition, that this disease proves fatal. These being once subdued, or a truce gained, as the first and indispensable ground-work, it will be essential to profit by such a remission of the spastic state, in vigorously supporting the system generally, and the nervous part of it more particularly, in order that the patient may not sink under the violence of the exacerbations he has to encounter, during his perilous struggle.

"In fulfilling the first and most indispensable intention, *opium* would seem from analogy to be peculiarly adapted to relieve the symptoms, especially the extreme irritability of mind and body; the complete loss of sleep, and the convulsions. Accordingly, it has been administered, and in some cases to an extent that is scarcely conceivable, and yet, *so* administered, without having been found to do any evident good. In one case, under the direction of Dr. Babington, the enormous doses of *twenty-five grains* and *half a drachm* were *repeated at small intervals*, so that *in eleven hours* no less than *a hundred and eighty grains* of *opium* were *swallowed* without any benefit, and without even producing any sleep †.

"That *opium* should thus have been tried in large and frequent doses, and persevered in to an enormous and frightful extent, surely affords an irrefragable evidence of its having been considered the most apposite remedy, while it is no less manifest, that the state of the gastric functions and sensibility differs in Hydrophobia from their condition in any other disease, or in health.

"After such demonstration has been given us of the inefficacy of *opium* administered by the *stomach*, it seems incumbent on us either to expunge it from the catalogue of antilyssic remedies, or employ, if possible, some more effective mode of introducing its *narcotic* power into the system.

"Through the *direct* medium of the circulation, by injection into the

* *Ed. Med. and Surg. Journal*, 1823.

† *Med. Records and Researches.*

veins, this intention seems capable of being fulfilled, and thus the first indispensable step in the cure of Hydrophobia gained. Nor is this reasoning hypothetical, or merely analogical. A late experiment of Professor Dupuytren at the Hotel Dieu* has given a *direct* and striking proof of the power of opium, when *thus* introduced into the circulation, to tranquillize the symptoms of Hydrophobia. His is, I believe, the first instance on record of injecting opium into a vein, as a remedy in that disease. But the quantity injected by M. Dupuytren was insignificant; in the whole, apparently not more than twelve to fourteen grains, in not less than as many hours. However, after the first injection into the saphœna vein of about *two* grains of the mucous extract of opium, the patient appeared *more quiet*, which suggested to M. Dupuytren the idea of doubling the dose of the injection in the evening. He then made choice of the cephalic vein, and introduced into the circulation *four* grains of opium. Th e patient remained for '*three hours in the most perfect tranquillity*'—and so indeed did M. Dupuytren. Not the slightest advantage appears to have been taken by him of this all-important conquest of the spasms, for the introduction of any active remedies into the stomach. After the long and precious interval of apparently twelve hours had elapsed, then six or eight grains more were injected. It was too late. The patient did not survive the last injection more than half an hour. Here was a specimen of *la medicine expectante* in Hydrophobia. M. Dupuytren, in short, seems to have relied solely and exclusively upon the injection of opium into veins for a cure, whereas this measure is only preliminary. The practitioner is not to trust to this measure alone, but to employ it as a preparatory step, by which the spasms and nervous irritability may be subdued, and the patient brought into a calm and tractable state. The disease must then be treated on the general therapeutical principles, rendered applicable to it in common with other diseases, and being reduced to their level, opportunity is given and must be used, for administering remedies both liquid and solid, in the usual way†.

"From the experiments of M. Majendie, made by injecting opium into the jugular vein of a rabid dog ‡, analogy would lead me to infer that the same mode of introducing narcotics into the human system, when affected with Hydrophobia, can be expected to prove little better than nugatory, unless it be followed up with considerable vigour and decision.

"I consider the *acetate of morphine* as far preferable to opium, for the purpose of being injected into the veins of the hydrophobic patient. Its dose and powers are more definite than those of opium, which latter substance varies in intensity of narcotic power according to the source from which it is derived§.

"In the *actetate of morphine* we have, in a very concentrated form, the anodyne and sedative powers, divested of that stimulant principle, which produces the excitement experienced by those who take opium, before its sedative effects are felt. The diaphoretic property of *acetate of morphine* also strongly recommends it in the present instance; since, at all times the animal frame is most disposed to be quiet and free from irregular actions, when there is a general moisture on the surface. In many cases of rabies such a state of body has been found unquestionably serviceable.

"In conducting the injecting process, I would begin at once by introducing twenty-four minims of the solution of *acetate of morphine*, (equal to four grains of opium), mixed with two drachms of distilled water, into the cephalic vein, and waiting for about *ten minutes* to observe the effect, (which

* *Orfila on Poisons*, vol. ii. p. 216.

† See the *Ed. Med. and Sur. Journal* for some practical hints on this subject, by my learned friend Dr. Richard Pearson, to whom I acknowledge myself indebted for his valuable communications, of which I have availed myself.

‡ *Foreign Med. Review*, 1822.

§ *Thompson's London Dispen.*

with the acetate of morphine administered in this mode may be expected to be fully produced in that time), I would repeat the injection if necessary, and continue the repetition at like intervals until a decided sedative impression should have been produced.

"Care should be taken to warm the fluid and the syringe to about blood heat, in order to prevent any repulsive or chilling sensation being imparted to the patient by the difference of temperature. The syringe should terminate in a small bent silver tube, which should be inserted for about half an inch within the orifice, and in the direction of the returning blood.

"The patient should be hoodwinked by tying a pocket handkerchief over his eyes, and reclined on the bed, his legs being tied together. The arm opposite to that which is to be operated upon should be held fast by an attendant. The arm which is chosen for the operation should also be held firmly while the injection is taking place.'

"These precautions are requisite, as in some cases the sight of the syringe, the fluid to be injected, or the blood issuing from the vein on opening it, would excite violent spasms."—Pp. 11-16.

It will be seen from the above quotation, that Dr. Booth's plan of treatment is a *mere suggestion*, but we think it a very plausible one, and trust that at all events its merits or its demerits will be ascertained by fair and candid experiment.

There is one part of his subject to which we wish our author had paid more attention, namely, the preventive treatment to be resorted to previous to the accession of symptoms. Has a course of mercury ever had a fair trial in the period intervening between the bite and the accession of the disease? Has copious bleeding ever been used in that period? Might not a person be plausibly kept under the influence of narcotics and anti-spasmodics previous to the occurrence of symptoms? and might it not be expected that they would be modified or mitigated by such or some similar means?

II. *The History of Ancient and Modern Wines.* 4to. pp. 407. London. Baldwin, Cradock, and Joy, 1824.

We believe the author of this expensive quarto to be Dr. Henderson, the physician, but as he has thought fit to omit his name and attributes in the title-page, we only guess at them from the signature to the preface. Be this as it may, such a work was much wanted, and although the Doctor is, upon the whole, more learned than useful, and abounds more in "wise saws and modern instances," than in the minutiæ of practical details, he has filled up with tolerable materials a gap that has long existed in the history of one of our greatest luxuries; although too, much remains for the completion of the subject, his labours will at all events furnish a useful peg upon which some more accurate and scientific labourer in the vineyard may suspend his future remarks.

In an introductory chapter our author introduces some general observations respecting the principles of fermentation, and the constituents of wine in general, adverting to those well known

circumstances which so considerably influence the latter, and which refer to the quality of the grape, the climate and soil most congenial to its culture, and the aspect in which it grows: the time of year too when the vintage is collected, the preparation of the fruit previous to its being pressed, and the various modifications of fermentation that are adopted, all tend to modify the character of the wines. Thus, the brisk wines are usually made from grapes barely ripe; dry and full-bodied wines from those which are fully mature; while the luscious sweet wines are often procured from grapes which have been allowed to shrivel upon the stalk, or which are nearly converted into raisins by spreading out the vine which bears them upon straw, and thus exposing them fully to the desiccating influence of the sun. In every part of the process of wine-making the utmost attention to cleanliness is requisite; the rotten and green grapes should be carefully excluded, and all the vessels employed should be well aired and cleansed, and perfectly free from any thing that can in any way influence the contained liquor: it is curious how much the flavour of a wine is frequently influenced even by the most trivial inattention to such circumstances, and how often it happens that bad wine results from the best grapes grown under the most auspicious climate, from the innate filthiness and habitual laziness of the inhabitants, and of the managers of the process.

Among other circumstances which very materially influence the quality of the wine, we may enumerate the addition of the stalks of the grape, which, though sometimes intentionally added, are generally mischievous, and there can be little doubt that many wines are spoiled to save the trouble of picking the grapes. In port-wine the stalks are generally used, and perhaps contribute to its roughness; we have, however, tasted port-wine fermented without the stalks, and from grapes carefully picked from all green and rotten intruders, which was of most exquisite quality. From all the best wines of Bourdeaux, and from those of the Rhine, the stalks are always excluded, and we shall find that among the various causes that contribute to the general excellence and delicacy of the French wines, the cleanliness and attention with which they are manufactured are perhaps the most essential.

The general character of the wine is also affected by the husk of the grape, to which the colour is usually referable, there being but few grapes having a coloured pulp; one of these, the *tintilla*, or *teinturier* grape, furnishes a rich and deep-coloured wine independent of the hull. Where the colour is derived from the skin, its extraction requires a full and perfect fermentation; and although strong pressure will give a light tinge to the juice, we rarely find wines red and brisk (*i. e.*, imperfectly fermented) at the same time.

Upon the important subject of the perfume or aroma of wines

Dr. H.'s remarks are quite unsatisfactory; he speaks of it as of a principle existing in the grape, but it appears to us that it is as often a *product* as an educt; and that in respect to many varieties of the grape they afford a wine, the excellence of which depends on a very fleeting but powerful *bouquet*, of which not a trace is discoverable previous to fermentation. Among others, the wine of Tonnerre may be selected as an instance; its exquisitely musky and rosaceous aroma, so agreeable both to the nose and palate of the drinker, are quite wanting in the grape, which in those respects is of an inferior order.

Our author's observations on the vinous and acetous fermentations dispersed through this chapter are merely abstracted from chemical treatises, and that not very judiciously; nor are his remarks on the disorders of wines, their ropiness, acescency, and bitterness, at all luminous or satisfactory; the latter quality manifests itself occasionally in Burgundy, but is only of temporary duration; Dr. H. ascribes it to the formation of "citric ether, which is known to have an extremely bitter taste." This is the first time we ever heard of such a species of ether. Nor is he quite correct when he says that alcohol may be separated from the wine "in a pure state" by mere distillation. But we do not wish to dwell upon these slips and peccadillos, to which the best of us are subject, and shall therefore proceed with our "history," the first part of which relates to Ancient Wines, and the first chapter to the "Vineyards of the Ancients," of which the initiatory vignette represents we know not what, unless it be Rolla bearing away the child, in the tragedy of Pizarro *.

Our author here gives an interesting, though superficial, sketch of the cultivation of the vine, as practised by the ancients; and it is curious to observe how little change the lapse of two thousand years has in most respects effected in this branch of husbandry. The ancients were also acquainted with numerous varieties of the vine. The *vitis apiana*, so called from its liability to be attacked by bees, and which has now received the correspondent appellation of *muscadine*, was in very high repute; the Aminean was also a favourite vine, so was the Nomentan, called also *fecinia*, probably from the abundant deposit from its juice during fermentation.

" That the ancients spared no pains or expense to procure all the best kinds for their vineyards, is proved by the accounts which

* We beg our author's pardon: we find from the list of engravings that it represents "Mercury conveying Bacchus to the Nymphs." When these ornamental wood-cuts are very nicely executed and as carefully printed off, they are real embellishments, as we see in some of the beautiful specimens that adorn Mr. Dibdin's books, but they only succeed in the hands of a true bibliophilist. Dr. Henderson's designs are good, but the execution is often paltry, and the printer, in our copy at least, has spoiled all: many are mere dabs of ink.

they give of the effects of their transplantation: and that they confined their attention to such as were found to answer best with particular soils, may be inferred from the manner in which they describe certain spots as planted with a single species; as for example the hills of Sorrento and Vesuvius, which were covered with the small Aminean grape. There is, in fact, no part of the writings of the ancient agriculturists which is more deserving of being recalled to notice, than those passages in which they declaim against the bad effects of the promiscuous culture of many varieties of the vine, and recommend the husbandman to plant only such as are of good and approved quality. But as all are not equally hardy, Columella thinks it may be well, in order to guard against a failure of the crop from unfavourable seasons, to keep three or four, or at most five sorts, which will be amply sufficient for the purpose. These he would dispose in separate divisions of the vineyard, so that the fruit of each may be kept apart, and gathered by itself when it ripens. In this way, he observes, the labour and expense of the vintage will be lessened, the mixture of ripe and unripe grapes will be in a great measure avoided, the genuine flavour of each sort will be preserved entire in the must, and improve in the wine, until it has reached its utmost perfection."—Pp. 31-32.

In low and warm situations the vintage began in September, but it was in most places deferred till October. The juice, when too thin or watery, was often evaporated, and when its fermentation in the vat had ceased, it was generally at once introduced into the vessels in which it was intended to remain for use. Of these vessels the most ancient were probably composed of the skins of animals, but as the arts improved vessels of clay were substituted, and the method of rendering them impervious by a glazing being then unknown, they were coated with pitch, in order to prevent the transudation of the liquor; these vessels were sometimes large enough to hold upwards of three hogsheads, and it was customary to protect them by leaden or oaken hoops. In the vicinity of the Alps, in Illyria, and elsewhere, wood being abundant, wine-casks were occasionally made of that material. Glass was probably very rarely employed; at the supper of Trimalcio, however, so admirably depicted by Petronius, even amphoræ of glass are said to have been introduced.

The vessels containing the wines were either placed in the open air, or in cellars, where they were properly arranged and labelled; they were also often exposed to warmth to bring them early to perfection.

"The ancients were careful to rack their wines only when the wind was northerly, as they had observed that they were apt to be turbid when it blew in an opposite direction. The weaker sorts were transferred in the spring to the vessels in which they were destined to remain; the stronger kinds, during summer; but

those grown on dry soils were not drawn off until after the winter solstice. According to Plutarch, wines were most affected by the west wind, and such as remained unchanged by it were pronounced likely to keep well. Hence, at Athens and in other parts of Greece, there was a feast in honour of Bacchus, on the eleventh day of the month Anthesterion, when the westerly winds had generally set in, at which the produce of the preceding vintage was first tasted. In order to allure customers, various tricks appear to have been practised by the ancient wine-dealers; some, for instance, put the new vintage into a cask that had been seasoned with an old and high-flavoured wine; others placed cheese and nuts in the cellar, that those who entered might be tempted to eat, and thus have their palates blunted before they tasted the wine. The buyer is recommended by Florentinus to taste the wines he proposes to purchase during a north wind, when he will have the fairest chance of forming an accurate judgment of their qualities." —Pp. 58, 59.

As in all the more southern climates, the grape attains its full maturity, and abounds in saccharine matter, a large proportion of the Greek and Asiatic wines were probably both sweet and strong. Homer seldom mentions wine without some epithet indicative of such a quality. That they were also acquainted with sparkling and frothing wines appears from frequent allusions of the poets to those properties. It is stated by Galen that the generous wines were not fit for drinking before the fifth year: the majority of them were, however, kept for a much longer period; the Surrentine wine for instance was raw and harsh until about twenty years old.

The ancients seem to have been fully skilled in the rules by which a good and durable wine is to be known; that grown on high grounds, produced from vines bearing a small quantity of fruit, and having, when recent, a harsh flavour, was deemed most sound and durable. In allusion to this quality Seneca quotes the remark of Ariston, "that he should give the preference to a youth of grave disposition, rather than to one conspicuous for gaiety and engaging manners, for that wine is observed to become best which, when new, is hard and rough; but that which pleased in the wood was not durable."

It is probable that the ancients were always in the habit of diluting their wine either with cold or hot water, and accordingly our author devotes a chapter to the methods of diluting and cooling ancient wines, justly eulogizing the labour and expense with which they obtained an abundant supply of pure spring-water, instead of being content, like modern nations, to fill their cisterns with the muddy and putrid produce of rivers and canals. It is, indeed, somewhat unaccountable that the inhabitants of London so tamely submit to the filth which the water-companies, at enormous charges,

pour in upon them, and which generally more resembles pea-soup than water, contaminating the cisterns, clogging the pipes, and fouling every article which comes in contact with it. It is true that those persons who are not provided with a well generally send to some neighbouring pump, where excellent and pure spring-water, very abundant when from sufficient depths, may be copiously obtained; yet we are surprised that, in the present plethoric state of capital, no company has been formed to supply houses with pure spring-water; a few overflowing wells would afford ample supply, and iron-pipes for its conveyance are liable to no kind of objection.

But the ancients were not only curious in the purity of the water; they also cooled and iced it in various ways; indeed the custom of preserving snow for summer use probably prevailed among the oriental nations from the earliest ages *, and was certainly long familiar to the Greeks and Romans, who preserved snow in pits covered with branches, straw, or coarse cloths. In the time of Seneca ice so preserved was not only sold in the shops in Rome, but hawked about the streets, and at this day the inhabitants are similarly supplied, the ice being carried into the city in the night-time in carts covered with straw.

"It is curious to remark," says Dr. Henderson, "especially when we consider the character of the age in which they were written, the loud lamentations of Seneca with respect to this very natural and harmless species of luxury. 'To what a pitch,' he exclaims, 'have our artificial wants brought us, that common water, which nature has caused to flow in such profusion, and destined to be the common beverage of man and other animals, should, by the ingenuity of luxury, be converted into an article of traffic, and sold at a stated price! The Lacedemonians banished perfumers from their city and territory, because they wasted their oil. What would they have done, if they had seen our shops and storehouses for snow, and so many beasts of burthen employed in carrying this commodity, dirtied and discoloured by the straw in which it is kept? You may behold certain lean fellows, wrapped up to the chin to defend them from the cold, and pale and sickly in appearance, who not only drink, but even eat snow, putting lumps of it into their cups during the intervals of drinking. Do you imagine this to be thirst? It is a true fever, and of the most malignant kind.' Even Pliny is disposed to grudge his cotemporaries this simple indulgence. 'Some persons,' he says, 'drink snow, others ice; rendering, in this way, the hardships of the mountainous regions subservient to the gratification of the palate:

* "As the cold of snow in the time of harvest, so is a faithful messenger to them that send him: for he refresheth the soul of his masters."—Proverbs, chap. xxv. ver. 13.

and cold is preserved during summer, in order that they may ice their cups, notwithstanding the warmth of the season. Some boil the water first, and then freeze it. In short, man is satisfied with nothing in the state that he receives it from the hand of nature.' These declamations, however, passed unheeded; the usage in question became universal, as the frequent allusions to it by ancient authors sufficiently prove, nor was it confined to the summer months, but was continued by many through the depth of winter; as is still the case in the south of Italy and in Sicily, where iced water has become an article of prime necessity, and is sought for at all seasons with an avidity which, to a native of our northern clime, appears at first view quite unaccountable. 'It is from a volcano,' Dr. Irvine observes in his Letters from the latter country, 'that the inhabitants are abundantly supplied with this refreshment. The noise and tumult at the houses where the snow is sold, as fast as it arrives from Etna, is even alarming to a stranger; and I thought the first time that nothing less than murder could have occurred within, seeing the doors besieged by so clamorous a mob. When the thermometer is at 88° of Fahrenheit in the shade, there is something in this eagerness which we can understand: but in this country, when snow is lying on the ground, when cold and damp winds send one shivering for shelter, even then the Sicilian must have his iced water. There is no weather so cold as to drive him from his wonted refreshment. He seems as if resolved to make the greater cold expel the less.'"—Pp. 108, 109.

In the concluding chapter of this part of his work, Dr. Henderson has given us some amusing remarks connected with the use of wine at the banquets of the Greeks and Romans. The drinking vessels of the higher ranks were enriched with the works of the sculptor, lapidary, and jeweller, and even the ivy and beechen bowls of the poorer classes were often so curiously carved that the beauty of the workmanship compensated for the meanness of the materials. Athens took the lead in the manufacture of earthenware vases, "but the potteries of Samos soon rose into equal repute, with those of Saguntum in Spain; and Surrentum, Arretium, and one or two other towns in Italy, furnished the chief supply." These vessels are are good samples of the perfection of the art; they were thin and light, and varnished with bitumen to render them impervious. The Egyptians, and particularly the Alexandrians, were no mean artists in glass, and from the banks of the Nile the Romans were supplied with drinking vessels of that material. Dr. Henderson here adverts to the discussion concerning the nature of the celebrated *Murrhine* vases, and agrees in opinion with M. de Roziero, that they were formed of fluor-spar; this, however, is mere conjecture, and is chiefly founded upon the

circumstance of their imitations in paste having zigzag belts of blue and yellow.

"At the banquets of heroic times each guest had a separate cup, and larger cups and purer wine were presented to the chiefs, or those friends whom the master of the feast desired to honour. It was also a mark of respect to keep their cups always replenished, that they might drink as freely and frequently as they inclined. The wine which had been previously diluted to the requisite standard in a separate vessel (κρητὴρ, ψυκτὴρ), was served by the attendants, who were either the heralds of the camp, or boys retained for that purpose. Besides these cup-bearers, the wealthy Athenians had their butlers, or inspectors of the wine (οἰνόπται) whose business it was to watch the movements of the table, and see that all the guests were properly supplied. At the conclusion of the dinner pure wine was handed round; but before it was drunk a portion of it was poured upon the ground or table, as an oblation to Jupiter and all the gods, or to some one deity in particular; and the cup was always filled to the brim, as it was held disrespectful to offer any thing in sacrifice but what was full and perfect. Hence the goblets were said to be crowned with wine. The wine used on these occasions was of the red sweet class, probably because it was the richest and strongest, or was the customary dessert-wine. It may be remarked, that the same kind of wine is still employed for sacramental purposes, and the appellation of *vino santo*, which is given by the Italians to their most luscious growths, is probably allusive to this circumstance."—Pp. 117, 118.

It would be departing from our subject to detail the ceremonies generally observed at those feasts of the Greeks and Romans; but it is curious, as our author remarks, to observe how nearly they coincide with the convivial customs of the present day. The general order and arrangement of our dinners, the manner of pledging our friends, and even of drinking bumper toasts, are all copied from the ancients; and the festive habits of the French are yet more in unison with the ancient usages. Their common wines they usually dilute with water, while the more choice kinds (*vins d'entremets*) are handed round between the courses, and the luscious sweet wines are reserved for the dessert.

We must here, somewhat unwillingly, take leave of our author as the historian of ancient wines: it will be evident from our abstract that he has well arranged his subjects, and that they are generally treated of in readable and interesting narrative; there is a good deal of repetition in his details, and nothing very striking or original in his remarks and illustrations, but his sketch of the subject is perspicuous, and his references to authorities sufficiently copious and exact; and, as we before remarked, he has filled up a chasm in this department of our literature.

Into his introductory chapter to the history of Modern Wines, Dr. Henderson has infused much that is irrelevant and prosy, and after descanting at length upon the difficulty of framing a satisfactory classification of wines, ends his disquisition by dividing them into Red and White as *classes,* and into Dry and Sweet as *orders.*

The wines of France justly claim our first attention, being eminently superior to all others. Their soil, surface and climate are all favourable, and the manufacture is, with few exceptions, conducted with extraordinary care, and no small portion of scientific skill. Their modes of training and cultivating the vine are extremely various. In some of the southern provinces it twines upon the elm or maple, in others it is borne upon trellises, in others trimmed into bushes, and in others trained horizontally upon low rails.

Our author describes the wines of France under five sections:

1. *Of the Wines of Champagne.*—The principal growths of this province are in the department of the Marne, and are divided into river and mountain wines, *Vins de la Rivière de Marne,* and *Vins de la Montagne de Reims*; the former are mostly white, and more or less brisk, and the latter red and still. Among the best river wines are those of Ay, Epernay, and Hautvilliers; they are well known as most exquisite liquors, bright, nearly colourless, light, creaming, sweetish, and having a most indescribably exquisite aroma. Sillery is also no mean wine; it is stronger, more durable, and rather deeper coloured than the former, and although once preferred in this country, is now less esteemed than the most choice wines of Ay, *&c.* In reference to this subject we entirely agree with one of our best judges, who, in reply to one that defended Sillery, observed, "that all Champagne would be sweet *if it could.*" Of the mountain wines, Clos St. Thierry deserves especial commendation; when of *première qualité* it unites the "rich colour and aroma of Burgundy with the delicate lightness of Champagne." There are, however, many other red Champagne wines which are not to be despised, especially those of Hautvilliers; but these have declined in repute since the suppression of the monastery to which the principal vineyard belonged, and one of the monks of which was the contriver of an apparatus very similar to one which has lately been trumped forth to the brewers and cider makers of this country, under the title of *Appariel Gervais.*

"For the manufacture of the white Champagne wines black grapes are now generally used. They ripen more easily, and resist the frosts and rains common about the time of the vintage much better than the white sorts. Hence the wines which are made from them alone, or from a mixture of the two, are not so liable to degenerate as those prepared from white grapes only.

They are picked with great care, those which are unripe, shrivelled, or rotten being rejected; they are gathered in the morning, while the dew is yet upon them, and it is remarked that when the weather happens to be foggy at the time of the vintage, the produce of the fermentation is considerably increased. They are then subjected to a rapid pressure, which is generally finished in an hour. The wine obtained from this first operation is called *vin d'élite*, and is always kept apart from the rest. After the edges of the murk have been cut and turned into the middle, another pressing takes place, which furnishes the *vin de taille* (*vinum circumcisitum* of Varro); and the repetition of these processes gives the *vin de deuxième taille*, or *tisanne*. The liquor procured by these successive pressings is collected, as it flows, in small vats, from which it is removed early on the following day into puncheons which have been previously sulphured. In these the must undergoes a brisk fermentation, and is allowed to remain till towards the end of December, when it becomes bright. It is then racked and fined with isinglass, and in a month or six weeks more is racked and fined a second time. In the month of March it is put into bottle. After it has been about six weeks in bottle it becomes brisk, and towards autumn the fermentation is often so powerful as to occasion a considerable loss by the bursting of the bottles, but after the first year such accidents rarely happen. A sediment, however, is generally formed on the lower side of the bottle, which it becomes necessary to remove, especially if the wine be intended for exportation. This is accomplished either by racking the wine into fresh bottles, or, if it be already brisk, by a peculiar manipulation termed *dégorgement*, the sediment being allowed to settle in the neck of the bottle, from which it is forced out on drawing the cork. These operations, and the loss sustained by them and by the bursting of bottles, which is seldom less than twenty per cent., and often much more, necessarily enhance the price of the wine. The Sillery wines are kept in the wood from one to three years before they are bottled." — Pp. 157, 158.

The varieties of pink Champagne are either tinged by the husk of the grape, or by a colouring matter composed of elderberry juice and cream of tartar.

The finest Champagne will keep from ten to twenty years; the creaming wine of Ay has even been known to keep, and to improve by keeping, for a longer period. The vaults in which it is stored should be cool, and of an uniform temperature; in those of M. Moët at Epernay, which are excavated in calcareous rock to a depth of about forty feet, the thermometer rarely varies a degree from 54°.

2. *Of the Wines of Burgundy.*—Well might the Dukes of Burgundy be designated as the *Princes des bons vins*, for in point of richness and perfume the wines of that province are unrivalled.

They are produced in the greatest excellence and variety in the departments of the Côte D'Or, Yonne, and Saône and Loire. At present the Romané Conti, Clos-Vougeot, and Chambertin are considered as the most choice growths of the Côte D'Or. Upon the subject, however, of the Burgundy wines which come to England our own observations sanction Dr. Henderson's conclusions; he shall therefore speak for himself.

"In England we have in general a very imperfect idea of the great variety and excellence of the wines which this province produces, as it is customary to comprehend them all under the generic term *Burgundy*, and as the prime growths are confined to a few favoured vineyards, and are in great request in their own country, it is evident that but a small proportion of them can ever come into the market. Supposing, therefore, our wine merchants chose to give the high prices at which such wines sell, they could not obtain a sufficient supply; but the high and impolitic duty on French wines renders it their interest to limit their orders for the most part to inferior qualities, or if they should commission the best it is still not unlikely that the French wine-dealer, unable to meet the demand, and unwilling to disappoint his rich, but not very skilful, foreign customers, might be induced to send second-rate wine, which, with persons habituated to the duller liquors of Spain and Portugal, may seem of the very finest quality. Nor does this statement rest altogether on supposition, for we are told by Jullien, that the ordinary wines of first and second quality,—the inferior produce of the vineyards of Vosne, Nuits, Volnay, Pomard, Beaune, Chambolle, and Morey, are often exported under the denomination of the best, to those countries where the first qualities are not duly appreciated; and indeed the practice in question is notorious, not only in Burgundy, but in all parts of the world where wine forms an article of commerce."—P. 163.

The white wines of Burgundy are less known here than the red, but some of them are excellent, Mont Rachet and La Perrière, for instance, and some of the wines grown in the vicinity of Chablis.

3. *Of the Wines of Dauphiny, the Lyonais, and the County of Avignon.*—The famous vineyards of the Hermitage are upon a granite hill immediately behind the town of Tain, on the left bank of the Rhone; the whole slope faces the south, and from its steepness is partly formed into terraces. Of the red wines of this district those of Méal and Greffieux, and next to them those of Bessas and Beaume, are most esteemed; they have a full body, a dark purple colour, and a peculiar flavour and perfume; they require to mellow several years in the cask, where they deposit abundance of tartar; they keep long in the bottle, and their exquisite qualities are then only slowly developed.

The wines of Côte Rôtie are the produce of the terraced vine-

yards formed in the southern declivity of the hill to the west of Ampuis, on the right bank of the Rhone, about seven leagues from Lyons. In flavour and perfume they approach to the richness of the Hermitage, but are inferior as to strength and body; they should not be bottled before the sixth or seventh year.

Among the white wines of the Rhone those of the Hermitage stand foremost; they are made of white grapes, and with the exception of the *vin de paille*, which is made of grapes half dried upon straw, and is very rich and luscious, they are among the dryest of the French wines. Château Grillet and Condrieux, in this district, also afford good white wines, both sweet and dry.

4. *Of the Wines of Languedoc, Roussillon, and Provence.*—With all their advantages of situation the wines of these provinces are generally inferior to those of the more northern departments; many of the red wines, however, of Languedoc are held in deserved estimation, and those of Roussillon, when duly kept both in cask and bottle, are remarkable for their body and richness. Most of the red Provence wines, on the contrary, are of decidedly inferior quality. In the class of dry white wines those of St. Peray on the Rhone, nearly opposite Valence, and those of St. Jean, near Tournon, are of a respectable character.

But these provinces make ample amends in the exquisite and unrivalled sweet or Muscadine wines, such as those of Frontignan, Lunel, and Beziers, in Languedoc; and of Rivesaltes and Salces, in Roussillon. We may observe, in regard to these wines, that those which are deep coloured and deficient in flavour and perfume, are generally grown in the country around Beziers; some of these, when old become dry, and are not unlike some of the Spanish white wines.

"Two leagues east from Perpignan is the celebrated vineyard of Rivesaltes, which gives the best muscadine wine, not only in Roussillon, but in France, or perhaps in the whole world, for it is much more perfect of its kind than many others to which an undue degree of excellence is ascribed, merely because they come to us from a great distance, and are remarkable for their rarity and costliness. When sufficiently matured by age it is of a bright golden colour, and has an oily smoothness, a fragrant aroma, and a delicate flavour of the quince, by which it is distinguished from all other sweet wines. The quantity produced does not exceed two hundred hogsheads. At Salces, a few miles further to the north-east, a white wine is grown, which, from the grape that yields it, gets the name of *maccabec*, and is thought to resemble Tokay, but in point of richness it is inferior to the Rivesaltes. Besides the growths above enumerated, the vineyards of Bagnols sur Mer, Collioure, and Cosperon, supply some red sweet wines called *grenache*, from a Spanish grape that is much cultivated in these districts. At first

they are high-coloured, and somewhat rough, but when kept a few years become lighter and milder, and approach in flavour to the wines of Rota."—Pp. 178, 179.

5. *Of the Wines of Gascony and Guienne.*—Whatever may be the excellence of the other French wines, those of the Bordelais are perhaps the most perfect; they keep well, are improved by sea carriage, and are exported to all parts of the world. The vineyards of this district are divided into those of Medoc, Graves, Palus, and Vignes-Blanches, which furnish the prime wines; while the territories of Entre-deux-Mers, Bourgeais, and Saint Emilion afford growths of secondary value. The Medoc district commences about thirteen leagues to the north of Bourdeaux, and extends along the left bank of the Gironde and Garonne as far as Blancfort, which is two leagues and a half below Bourdeaux; it comprehends the most celebrated growths of the country, such as Lafitet and Latour, Leoville, Château-Margaux, and Rauzan. The wines, both red and white, which grow on the gravelly lands to the south-east and south-west of Bourdeaux, are generally termed *graves*. The strong wines of the Palus and other districts are chiefly used to mix with the poor ones of Madoc, and our author informs us that there is a particular manufacture, called *travail a l'Anglaise*, which consists in adding to each hogshead of the genuine wine three or four gallons of Alicant or Benicarlo, half a gallon of Stum wine, and a small quantity of Hermitage. This mixture undergoes a slight fermentation, and is then exported as CLARET. We believe also that small quantities of raspberry brandy are added to some of the clarets intended for our market.

Among the white wines the *graves* are celebrated for their dryness and aroma; the choicest are from the vineyards of St. Bris and Carbonnieux; the growths of Pontac and Dulmon also closely resemble them. Sauterne, Barsac, and Preignac are sweetish when new, but they keep well, and get dry without loss of flavour.

Dr. Henderson next treats of the wines of Spain and Portugal. The Spaniards, he tells us, prefer the rich and sweet wines, and rate the growths of Malaga and Alicant more highly than those of Xeres. Spain undoubtedly produces some excellent wine, and might afford much more were it not for the inherent sluggish and careless habits of the proprietors. Sherry is among our best wines; it is made indiscriminately of red and white grapes, which, when fully ripe, are dried for two or three days upon mats, freed from the stalks, and picked. "They are then introduced into vats, with a layer of burnt gypsum on the surface, and are trodden by peasants with wooden shoes. The juice that flows from them is collected in casks, and these as they are filled are lodged in the stores, where the fermentation is allowed to take its course, continuing generally from the month of October till the beginning or middle of December. When it has ceased the wines are racked from the

lees, and those intended for exportation receive whatever addition of brandy they may be thought to require, which seldom exceeds three or four gallons to the butt. The wine thus prepared has when new a harsh and fiery taste, but is mellowed by being allowed to remain four or five years, or longer, in the wood, though it only attains its full flavour and perfection after having been kept fifteen or twenty years. Sometimes bitter almonds are infused in it, to give that nutty flavour which is so highly prized in this wine. The driest species of Sherry is the *Amontillado*, made in imitation of the wine of Montilla, near Cordova. As the quantity manufactured is very limited, it sells much higher than the other kinds." —Pp. 190, 191.

Of the red wines of Andalusia the *Tintilla*, or *Tinto di Rota*, is the only one worth notice, and it is excellent as a *liqueur* wine; it is rich, sweet, and strongly aromatic.

The wines which come to this country, under the denomination of Lisbon and Oporto wines, are grown along the course of the Douro, in the vicinity of Lisbon. They are always largely dosed with brandy, and when new are very rough, strong, and deep coloured; but when duly kept in wood and bottle they gradually manifest their aroma and flavour. We think our author scarcely allows port wine the merit which it deserves, and he is a little severe upon his countrymen for their well known attachment to that beverage. Now, although we have not the smallest objection to an occasional bottle of Champagne or of Burgundy, we should be sorry to see those wines ever and anon substituted for port, which suits the English climate and constitution. We beg, however, to be distinctly understood, that we mean good genuine port wine, not the abominable farrago sold at taverns under that name, and which is usually designated *very fair wine*.

In this part of his book Dr. Henderson makes some apt remarks upon the mischievous privileges of the Oporto Company; but this subject is in a measure irrelevant to the object of our review, which must be limited to the mere scientific portion of his work, and the practical details which it includes.

From the wines of Portugal we proceed to those of Germany and Hungary. Of the former, the wines of the Rhine grown between Mentz and Coblentz are entitled to our chief notice; the vineyards are generally upon the steep sides of lofty hills, and the choicest vintages are limited to what is called the *Rhinegau*, extending on the right bank of the river from Wallamp, a little below Mentz, to Rüdesheim, and including a space of about nine English miles in length, and four in breadth. The produce, however, of some of the vineyards above Mentz, and especially those of Hockheim on the Mayne, is nearly of equal excellence with the best Rhine wines.

" For the white wines, which constitute by far the greatest pro-

portion of those made in Germany, the grapes are separated from the stalks, and fermented in casks, by which means the aroma is fully preserved. The wine is freed from the lees by successive rackings, and, when sufficiently clarified, is introduced into tuns, where it is allowed to mellow, and continues to improve during a long term of years. Those used in the Rhinegau commonly hold eight *ohms*, or five and a half hogsheads; but, in other parts of Germany, they are of larger capacity. Formerly the great proprietors vied with each other in the magnitude of the vessels in which they collected and preserved the produce of their vines; and as the better growths are valued in proportion to their age, the stock of wines in the cellars belonging to the princes, magistrates, and richer order of monks, was often enormous. Most persons have heard of the Heidelberg tun, and other immense casks in which they have been kept for whole centuries. Nor is such a mode of preserving certain vintages so absurd as some writers have imagined; for the stronger wines are undoubtedly improved by it to a greater degree, than they could have been by an opposite system of management. But in practising this method, it is essential, in the first place, to keep the vessel always full; and, secondly, when any portion of the contents is drawn off, to replace it with wine of the same growth, or as nearly resembling it as possible. When such cannot be had, the vacant space may be filled up by introducing washed pebbles into the cask. The wine which Keysler drank at Strasburg, from a tun which bore the date of 1472, had become thick and acid, because these precautions were neglected. Had it been kept in bottle, this degeneration probably would not have taken place. For the more delicate growths, however, small vessels are certainly preferable."—Pp. 229-220.

The best wines of the Rhine are very distinct and peculiar; they are not generally strong, but abound in a flavour and aroma singularly their own, and always improved by age. At the head of these wines is the Schoss-Johannis Berger, and to it the choicest Steinberger is little inferior. The vineyards too of Hochheim yield abundant and excellent produce; but in respect to all these wines, season has great influence. The vintage is late, and if the weather be wet and cold, the wines are poor and sour: the hock of warm and dry seasons is always to be sought for.

Hungary has numerous vineyards, but it is to that of Tokay that we must chiefly direct our attention. Its wines came into vogue about the middle of the seventeenth century, when they were first prepared from picked and half-dried grapes; they are cloying, rich, and aromatic, and generally turbid; but our author's information respecting their varieties and manufacture seems imperfect. After describing the cultivation of the grape, he says—

"In order that the fruit may attain its fullest ripeness, the vintage is delayed as long as possible, seldom commencing till the end of October, or the beginning of November; by which time, in favourable seasons, a considerable number of the grapes have become shrivelled and half-dried. These are called *trockenbeeren*, or dry grapes, being chiefly supplied by the above-mentioned species of vine; and, as it is on them that the luscious qualities of the Tokay wines depend, they are carefully separated from the rest. When a sufficient quantity has been collected, they are introduced into a cask, the bottom of which is perforated with small holes; and the juice, which exudes from them without any further pressure than what proceeds from their own weight, constitutes the syrupy liquor termed Tokay Essence. This keeps without any further preparation, and is highly valued; though it always remains thick and muddy. To obtain the *ausbruch*, which is the next variety of wine, the *trockenbeeren* are trodden with the feet, and a portion of must from common grapes is poured over them,—the quantity varying according to the nature of the grapes and the quality of the wine desired; being for the richest sort only about half as much as is allowed for the inferior kind, or *maslas*. By this addition, the aromatic principle, which in some of the Tokay grapes is very powerful, becomes more fully extracted from the skins. The mixture is now stirred strongly, and the hulls and seeds, which rise to the surface, are separated by means of a net or sieve. It is then covered over, and in forty-eight hours generally begins to ferment. The fermentation is allowed to continue three days, or more, according to the state of the weather; and during its continuance, the must ought to be stirred morning and evening, and the seeds carefully taken out. When the process is thought to have sufficiently advanced, the liquor is strained, through a cloth or sieve, into the barrels in which it is to be kept; but it does not become bright until the end of the following year."—Pp. 227, 228.

The wines of Italy are unfortunately of little interest or importance, nor are they much known in this country, though some of them, if more carefully made and preserved, would probably prove of no indifferent character. Indeed, a wine has lately been imported from the Genoese territory, which is rich, sparkling, strong, and sweetish, and which vies with Champagne of the best quality. It bears in London the name of *Ligustico.* Among the Tuscan wines *Aleatico,* which is a kind of red Muscadine, is rich and well flavoured. Carmignano is also much esteemed; and in the Papal States the light Muscadel wines of Albano and Monte Fiascone, and the red and white wines of Orvieto deserve mention. The *Lacrymi Christi* of the Neapolitan territory is a red luscious wine, made in small quantities, and

almost exclusively reserved for the royal cellars; that which we sometimes meet with here is generally a poor fretty wine, without much flavour.

We differ with Dr. Henderson in his estimation of the Sicilian wines. Marsala, when originally good and well kept, is a fine dry generous wine; and the Muscadines of Syracuse and some of the growths of the hills at the foot of Mount of Ætna, do not yield to the choicest corresponding products of France or Spain, and far exceed those of Italy.

On the Greek wines our author is brief and unsatisfactory; they are very numerous and of all qualities, but they seldom reach England in any perfection. The fact is, that they are slovenly in their cultivation and manufacture, and whatever may be the natural advantages of climate and soil, these alone are insufficient without due attention to the growth of the vine, and to the collection of its fruit, and cleanliness and skill of manipulation. Thus it is that the generality of the wines of Italy, Sicily, and Greece, are so indifferent; and hence the eminent and exemplary badness of the Cape wines.

In Madeira the best vineyards are those of the south side of the island. The celebrated Malmsey is grown on rocky grounds exposed to the full influence of the sun, and the grapes are allowed to hang for about a month later than those used for the dry wines, so that they become over-ripe, or partially shrivelled. Another much esteemed wine is the *Sercial*; it is obtained from a grape which only succeeds on particular spots, and requires long keeping to confer upon it the full body and the rich aromatic flavour which are peculiar to it. Though brandy is added to all the Madeira wines, the necessity or utility of the addition appears extremely doubtful, and the fine and select wines must be injured by it; these, however, very seldom reach us in their genuine state, and the demand for Madeira wine so far exceeds that which the island can supply, that the market is thronged with all kinds of sophistications and substitutes.

The effect of an East or West India voyage in ripening and perfecting Madeira are well known, but unless the wine is originally good, it often does mischief, and the additional expense is serious. Madeira is sometimes *forced* as it is called, by placing it in heated rooms, like the *fumaria* and *apothecæ* of the ancients, and the wine thus treated is said to acquire the same mellowness and tint as when long kept, or sent to a hot climate. We know a gentleman very curious in Madeira wine, who assures us that all the benefit of an India voyage may be conferred upon it, by fixing the pipe for a few weeks to the beam of a steam engine, where it may get both warmth and motion.

Of the Canary wines there are several which closely approach

Madeira in quality, and are often passed off under that name; this is especially the case with the growths of Teneriffe; they always, however, want body and flavour.

The vineyards of the Cape of Good Hope are, with one exception, notorious for the execrable wine which they produce, and notwithstanding all that has been said concerning the want of proper soil, we must agree with our author in referring the failure chiefly to the avarice and thick-headedness of the Dutch farmers; besides which, villanous brandy, and worse rum, are abundantly added to the wines for exportation to prevent their tendency to acescent fermentation. The farms of Great and Little Constantine, situated at the eastern base of the Table Mountain, almost nine miles from Cape Town, produce, as is well known, very excellent wines. Our author says that they are deficient in flavour and aroma, and that it is chiefly owing to their rarity and extreme costliness that they have acquired such celebrity; in all which we differ from him *toto cœlo*. Of these wines the marked superiority is, no doubt, partly referrible to soil, but chiefly to the care and cleanliness with which the vintage is conducted.

Of the Persian wines the finest are produced upon the line of hills that stretch from the Persian Gulf to the Caspian Sea, and among them those of Shiraz are most esteemed, though they now no longer maintain their former celebrity. Shiraz is very little known here, except at the tables of first-rate connoisseurs; we have tasted it of very various qualities, and should compare the best to Sercial Madeira.

Dr. Henderson has a chapter on English wines, but the less, we think, that is said about them, the better. The praise which Philipott bestows upon Captain Toke's vineyards at Godington, in Kent, reminds us of a gentleman from the north, who maintained that his grapes, grown in the open air, near Perth, were infinitely finer than any to be met with about London; "but I must premise," he added, "that I prefer them a *leetle soor.*" The fact is, that the notion of cultivating the vine in this climate with any success is quite absurd. In Normandy and Picardy this culture has been relinquished, and even in Champagne the grape will not always ripen. What then is there to hope from the changeable and wet seasons of England. Besides which, grapes ripened on walls and trellises are never fit for the manufacture of good wine, and it is upon such fruit only that we can make any plausible trials.

In discussing the history of modern wines used in England, Dr. Henderson has given his readers a fair portion of entertaining anecdotes and information, but we have already bestowed so much space upon his work, that we must pass them over as not necessarily connected with its main object.

Even with Dr. Prout's assistance, our author throws little light upon the changes which wines suffer with age, and in the bottle; nor is his chapter on the "Mixture and Adulteration of Wines" much more luminous. He concludes as a doctor ought, with an essay "on the Dietetic and Medical qualities of Wine," from which we learn that to most constitutions a moderate use of wine is beneficial as a cordial and stimulant, and that like other poisons, when administered with judgment and discretion, it produces good effects. He, however, insinuates, that under any circumstances wine is to be viewed rather as a medicine than as a beverage adapted to common use; that people in health require no such stimulants, and that by the preternatural excitement of frame which it induces it must infallibly exhaust the vital powers. Under the apprehension, however, of injuring the revenue, and wounding the feelings of the many respectable persons to be found in the trade, we shall not enlarge upon these topics, nor set forth the multifarious evils which result to individuals and to the community from the use of wine. *

We have only further to remark, in respect to Dr. Henderson's Work, that its present presuming form of an expensive quarto, is in no way justified, either by its contents or embellishments; it would have made a respectable and useful octavo, and as such would have had a more extensive circulation; or if he had set his mind upon publishing a fine book, the wood-cuts should have been more nicely executed, and carefully worked off, and there should have been some additional embellishments, for which the drinking vessels of the ancients, the chief varieties of the grape, and sketches in the principal wine districts, would have furnished interesting and ample materials.

* In the Appendix Dr. Henderson refers to Mr. Brande's well-known table of the strength of wines, and accuses him of having had adulterated liquors palmed off upon him under genuine names. We were somewhat surprised at this insinuation, as in the original papers in which Mr. Brande established the fact that alcohol is not formed during the distillation of the wine, he particularly adverts to the pains which were taken to procure genuine and unadulterated samples, and we should presume that his opportunities of obtaining them were pretty extensive. That the strength of the best wines that can be procured is very fluctuating his table amply shews. Dr. Henderson, however, condescends to add, that he has abandoned the opinion which he once entertained, of fallacy in Mr. Brande's experiments, and largely quotes the table we have alluded to, as standard authority. The fact is, that because certain wines analyzed by Mr. Brande are stronger than those analyzed by Dr. Prout, Dr. Henderson chooses to infer that they "must have been mixed with a considerable quantity of adventitious *alcohol*." Mr. Brande might return the compliment, by inferring that Dr. Henderson's wines were mixed with a "considerable quantity of adventitious" *water*; but we must leave the chemical gentlemen to determine this point.

III. *Philosophical Transactions of the Royal Society of London, for the Year* 1824. Part I.

The following papers are printed in this Part of the *Philosophical Transactions:*

1. The Croonian Lecture. On the internal structure of the Human Brain, when examined in the microscope, as compared with that of Fishes, Insects, and Worms. By Sir Everard Home, Bart., V.P. R.S.

2. Some Observations on the Migration of Birds. By the late Edward Jenner, M.D., F.R.S.

3. On the nature of the Acid and Saline matters usually existing in the Stomachs of Animals. By William Prout, M.D., F.R.S.

4. On the North Polar Distances of the principal Fixed Stars. By John Brinkley, D.D., F.R.S., *&c.*, Andrew's Professor of Astronomy in the University of Dublin.

5. On the Figure requisite to maintain the equilibrium of a homogeneous Fluid Mass that revolves upon an Axis. By James Ivory, A.M., F.R.S.

6. On the Corrosion of Copper Sheeting by Sea Water, and on methods of preventing this effect; and on their application to Ships of War and other Ships. By Sir Humphry Davy, Bart. P. R.S.

7. A finite and exact Expression for the Refraction of an Atmosphere nearly resembling that of the Earth. By Thomas Young, M.D., For. Sec. R.S.

8. The Bakerian Lecture. On certain motions produced in Fluid Conductors when transmitting the Electric Current. By J. F. W. Herschell, Esq., F.R.S.

9. Experiments and Observations on the development of Magnetical Properties in Steel and Iron by percussion: Part II. By William Scoresby, Jun. F.R S.E., *&c.*, Communicated by Sir Humphry Davy, Bart., P. R.S.

10. On Semi-decussation of the Optic Nerves. By William Hyde Wollaston, M.D., V.P.R.S.

Our readers will find in the abstract of the proceedings of the Royal Society, given in our last Number (Vol. XVII. p. 250,) an account of all the Papers published in the present half volume of these *Transactions*, with the exception of the three first on the list, to which we shall now beg their attention.

At the commencement of the Croonian Lecture, Sir Everard Home very justly observes upon the impropriety of limiting our inquiries into the cause of Muscular Motion to the structure of the muscle itself, and points out the necessity of examining the structure of the brain and nerves in reference to the principle upon which muscular motion depends. After adverting to his former communications upon this subject, registered in the *Philosophical Transactions*, the author proposes in the present Lecture to compare the anatomy of the human brain with that of fishes, insects, and worms. He first describes the brain of the tench, from an annexed representation of which it appears to exhibit less medullary and cortical matter, in proportion to the size of the animal than that of the bird; its form is also less compact, being made up of spherical nodules, medullary on the surface, and internally cortical; its basis is nodulated, and in the centre is an oval cavity.

Entering upon the anatomy of the brain of insects and worms,

Sir Everard pays a merited tribute of praise to the memory of Swammerdam, who was generally remarkably correct in his observations and drawings—he committed one notorious error, that of representing the eyes of the garden-snail to be at the point of the horns; those organs, on the contrary, are mere feelers, abundant in nervous filament, but having no exterior corresponding with the cornea of the eye.

"In all the insect tribe I have examined (says our author,) the brain is formed upon the same general principle, but very different from that of fishes; the brain is in one mass; it is too small to admit of a particular description, but contains globules; and from the readiness with which it dissolves upon exposure, there is no doubt of there being a fluid contained in it. Besides this, which is admitted to be the brain of the insect, there is another substance connected to it by means of two chords. This second part has been, I believe, usually called the first ganglion, but when accurately examined it is similar in its texture to the brain; the two chords which unite them are not properly nerves, since they are upon their first exposure turgid, but soon collapse. These two substances with their uniting chords form a circle, and surround the œsophagus; from the upper mass go off the optic nerves, those to the tentacula, tongue, &c.

"From the lower mass go off the nerves to the upper extremeties.

"I shall therefore consider the upper as the brain, the lower as the medulla spinalis.

"Below this is a regular line of ganglions, properly so called, being made up of a congeries of nerves, as the ganglions in the human body are now admitted to be.

"The brain appears to be made up of two lobes. The mass I call medulla spinalis, is also made up of two portions, united together by the two lateral chords.

"The ganglions down the body of the animal are united together by a double nerve."—Pp. 5, 6.

Among insects the humble bee has the largest brain in proportion to the size of its body; it is of a truncated oval form, and gives off the nerves to the eyes and feelers; its internal structure is made up of globules. The substance corresponding in its uses to the medulla spinalis is nodulated on its external surface, and connected with the brain by two long chords, "which differ from nerves in collapsing soon after being exposed." In the moth, caterpillar, lobster, and earthworm, the structure of these parts corresponds with that in the bee. In the garden-snail the brain and medulla spinalis are, upon the whole, larger in proportion to the size of the animal than in the bee, "but in this animal there are no ganglions, which may account for those parts being so large." This absence of ganglions in the snail, while they exist in the other

insects enumerated, is certainly a curious fact developed by this investigation.

Sir Everard concludes this Lecture (which is illustrated by some good engravings from Mr. Bauer's drawings), with the following remarks :—

"Having ascertained that in all the animals, the structure of whose nervous system has been explained in the present Lecture, the brain is a distinct organ, varying in its size it is true, till at last it is scarcely distinctly visible to the naked eye, but when exmined in the microscope, found to consist of globules and elastic transparent matter, and more or less of a fluid, similar to the brain of animals of the higher orders; that there is also, at some distance from the brain, a second substance of similar structure, connected with the brain by two lateral chords; and that this second part gives off the nerves that go to the different muscular structures of the body; I consider myself borne out in the opinion that this part answers the same purpose as the medulla spinalis.

"The ganglions which form a chain connected so beautifully together by a double nerve, must be considered to have the same uses, whatever they are, as the ganglions in the human body, being equally composed of a congeries of nerves. These are facts, which, if they are allowed to be clearly made out, form an addition to our knowledge, and give confirmation to opinions not before satisfactorily established."—P. 7.

2. *Observations on the Migration of Birds.* By the late Edward Jenner, M.D., F.R.S.

The late Dr. Jenner's paper on the Migration of Birds is chiefly intended to develop some facts which he considers as hitherto unnoticed respecting the *cause* which excites the bird, at certain seasons of the year, to quit one country for another; he, however, assigns several preliminary pages to prove the "reality of migration," the fact itself not being, he says, generally admitted. To the many well known instances proving the ability of birds to take long flights, Dr. Jenner adds several others, chiefly with a view to disprove the reality of the hibernating system, or the hypothesis of a state of torpor. He also notices a fact not a little remarkable, which is, that several birds which absent themselves at stated periods, return annually to the same spot to build their nests. This he proved by cutting of the claws of certain swifts, and finding the birds thus marked for several succeeding years in their nesting places. The silly supposition maintained by the late Dr. Beddoes and others, that swallows and other birds, submerse themselves in ponds and rivers, and there become torpid, we do not think it requisite to combat, neither shall we quote Dr. Jenner's experiment upon the drowning of a swift to controvert the notion,

nor his observations upon the incapability of dogs, ducks, and other divers to remain long under water.

The immediate cause of migration is traced to those changes which take place in the birds at the coming on of spring, and which are subservient to the production of offspring; it directs them to seek a country where they can be for a while better accommodated with succours for their infant brood, than in that from which they depart; and that nesting is the chief cause of their errand is proved, by its occupying their attention from the day of their arrival to that of their departure. The cuckoo is singularly alert in this business, but as he deviates so widely from the common laws of the feathered society, our author selects the swift as a better example.

"The swift shows himself here about the beginning of May, (sometimes a few stragglers appear earlier) and by the beginning of August he has completely reared his young ones, which seldom consist of more than two. At once the old birds and their family take their leave and are seen no more for that season. Now his farther residence cannot be rendered unpleasant by any disagreeable change in the temperature of the air, or from a scarcity of his common food, which at this time abounds in the greatest plenty. This circumstance of the early departure of the swift, without a more apparent cause, seems to have excited much astonishment and perplexity in the mind of that attentive and ingenious naturalist, the late Mr. White, of Selborne. Speaking of the swift (Letter XXI. page 184,) he says, 'But in nothing are swifts more singular than in their early retreat. They retire, as to the main body of them, by the 10th of August, and sometimes a few days sooner, and every straggler invariably withdraws by the 20th, while their congeners all of them stay till the beginning of October, many of them all through that month, and some occasionally to the beginning of November. This early retreat is mysterious and wonderful, since that time is often the sweetest season of the year. But what is more extraordinary, they begin to retire still earlier in the most southerly parts of Andalusia, where they can be no ways influenced by any defect of heat, or, as one might suppose, defect of food. Are they regulated in their motions with us by a failure of food, or by a propensity to moulting, or by a disposition to rest after so rapid a life, or by what? This is one of those incidents in natural history that not only baffles our searches, but almost eludes our guesses!' Thus Mr. White.

"Now, should the principle I have laid down be admitted, namely, that these birds come here for scarcely any other purpose than to produce an offspring and retreat when the task is finished, how easily will all circumstances be reconciled? and how little mysterious will those things appear which naturally seemed unac-

countable, not only to the amiable author from whom the foregoing passage is taken, but also to others who have written before on the same subject." — Pp. 22, 23.

These purposes, then, being accomplished, the migrators return to their respective homes, and the mode of departure of the young birds is one of the most singular occurrences in the history of migration. It may be imagined that a bird which has once crossed the ocean might have something impressed upon it that should prove an inducement to its return, but this cannot be an incitement to the young one, and that the parent bird is not the guide is proved by the cuckoo, whose offspring finds a distant shore in safety, though it could never know its parent, for the old cuckoos leave us in July, when many of their eggs are yet unhatched.

The second part of Dr. Jenner's paper refers to winter birds of passage, which take their leave of us about the same time that the spring migrators are taking wing to pay us their annual visit. That they are not, as is sometimes supposed, brought here through hunger, is quite obvious, for when the redwing and fieldfare quit us, the country abounds with their favourite food, and they are at this time in the finest condition. These birds never risk incubation here, but some of the winter migrators, such as the snipe, wild-duck, and woodpigeon, breed here in considerable numbers, and among these the home-bred wild-ducks are easily distinguished by the meanness of their plumage, when compared to the brightness of that of the foreigners; they are also taken some weeks earlier.

Dr. Jenner remarks, that the food of redwings and fieldfares is not, as is commonly supposed, the haw, which they take in scanty quantities only, but that they feed on worms and insects, and that when a very hard frost sets in they often leave us for a time, in consequence of the scarcity of such food. Before a severe frost a numerous tribe of water-birds generally make their appearance, some of which seldom show themselves on any other occasion.

We shall now conclude with a long quotation from Dr. Jenner's paper, which is not without interest, and which is very creditable to the moral feelings of the author; it is certainly a digression from the main subject of his communication, and yet not irrelevant to it.

" We must observe, that nature never gives one property *only* to the same individual substance. Through every gradation, from the clod we tread upon to the glorious sun which animates the whole terrestrial system, we may find a vast variety of purposes for which the same body was created. If we look on the simplest vegetable, or the reptile it supports, how various yet how important in the economy of nature are the offices they are intended to perform! The bird, I have said, is directed to this island at a

certain season of the year to produce and rear its young. This appears to be the grand intention which nature has in view, but in consequence of the observation just made, its presence here may answer many secondary purposes; among these I shall notice the following: The beneficent Author of nature seems to spare no pains in cheering the heart of man with every thing that is delightful in the summer season. We may be indulged with the company of these visitors perhaps to heighten, by the novelty of their appearance and pleasing variety of their notes, the native scenes. How sweetly, at the return of spring, do the notes of the cuckoo first burst upon the ear, and what apathy must that soul possess that does not feel a soft emotion at the song of the nightingale, (surely it must be 'fit for treasons, stratagems, and spoils') and how wisely is it contrived that a general stillness should prevail while this heavenly bird is pouring forth its plaintive and melodious strains,—strains that so sweetly accord with the evening hour! Some of our foreign visitors, it may be said, are inharmonious minstrels, and rather disturb than aid the concert. In the midst of a soft warm summer's day, when the marten is gently floating on the air, not only pleasing us with the peculiar delicacy of its note, but with the elegance of its meandering; when the blackcap is vying with the goldfinch, and the linnet with the woodlark, a dozen swifts rush from some neighbouring battlement, and set up a most discordant screaming. Yet all is perfect. The interuption is of short duration, and without it the long-continued warbling of the softer singing birds would pall and tire the listening ear with excess of melody, as the exhilarating beams of the sun, were they not at intervals intercepted by clouds, would rob the heart of the gaiety they for a while inspire, and sink it into languor. There is a perfect consistency in the order in which nature seems to have directed the singing birds to fill up the day with their pleasing harmony. To an observer of those divine laws which harmonize the general order of things, there appears a design in the arrangement of this sylvan minstrelsy. It is not in the haunted meadow nor frequented field we are to expect the gratification of indulging ourselves in this pleasing speculation to its full extent, we must seek for it in the park, the forest, or some sequestered dell, half enclosed by the coppice or the wood.

"First the robin, and not the lark as has been generally imagined, as soon as twilight has drawn the imperceptible line between night and day, begins his lonely song. How sweetly does this harmonize with the soft dawning of day! He goes on till the twinkling sunbeams begin to tell him his notes no longer accord with the rising scene. Up starts the lark, and with him a variety of sprightly songsters, whose lively notes are in perfect correspondence with the gaiety of the morning. The general warbling continues, with

now and then an interruption, for reasons before assigned, by the transient croak of the raven, the screaming of the jay and the swift, or the pert chattering of the daw. The nightingale, unwearied by the vocal exertions of the night, withdraws not proudly by day from his inferiors in song, but joins them in the general harmony. The thrush is wisely placed on the summit of some lofty tree, that its loud and piercing notes may be softened by distance before they reach the ear, while the mellow black-bird seeks the inferior branches. Should the sun, having been eclipsed with a cloud, shine forth with fresh effulgence, how frequently we see the goldfinch perch on some blossomed bough, and hear his song poured forth in a strain peculiarly energetic, much more sonorous and lively now than at any other time, while the sun, full shining on his beautiful plumes, displays his golden wings and crimson crest to charming advantage. The notes of the cuckoo blend with this cheering concert in a perfectly pleasing manner, and for a short time are highly grateful to the ear; but sweet as this singular song is, it would tire by its uniformity, were it not given in so transient a manner. At length evening advances, the performers gradually retire, and the concert softly dies away. The sun is seen no more. The robin again sends up his twilight song, till the still more serene hour of night sets him to the bower to rest. And now to close the scene in full and perfect harmony, no sooner is the voice of the robin hushed, and night again spreads a gloom over the horizon, than the owl sends forth his slow and solemn tones. They are more than plaintive and less than melancholy, and tend to inspire the imagination with a train of contemplations well adapted to the serious hour. Thus we see that birds, the subject of my present inquiry, bear no inconsiderable share in harmonizing some of the most beautiful and interesting scenes in nature."—Pp. 35-38.

3. *On the Nature of the Acid and Saline Matters usually existing in the Stomachs of Animals.* By William Prout, M.D., F.R.S.

The object of Dr. Prout's paper is to investigate the nature of the acid and saline matters usually existing in the stomachs of animals; he introduces the subject with some remarks upon the previous opinions of chemists and physiologists, in relation to the nature and sources of the acid and salts in question, and then proceeds to the detail of the experiments which led him to conclude that the free acid in the stomach is *muriatic acid*, and that the salts are the alkaline muriates. We wish our chemical readers to determine for themselves how far these points are satisfactorily proved, and therefore lay before them the details in Dr. Prout's own words.

"The contents of the stomach of a rabbit fed on its natural food,

were removed immediately after death, and repeatedly digested in cold distilled water till they ceased to impart any thing to that fluid. The whole of these different portions of fluid, which always exhibited strong and decided marks of acidity, were then intimately mixed together, and after being allowed to settle, were divided into four equal portions. 1. The first of these portions was evaporated to dryness in its natural state, and the residuum burnt in a platinum vessel; the saline matter left was then dissolved in distilled water, and the quantity of muriatic acid present determined by nitrate of silver in the usual manner; the proportion of muriatic acid, in union with a *fixed* alkali was thus determined. 2. Another portion of the original fluid was super-saturated with potash, then evaporated to dryness, and burnt, and the muriatic acid contained in the saline residuum determined as before. In this manner the *total* quantity of muriatic acid present in the fluid was ascertained. 3. A third portion was exactly neutralized with a solution of potash of known strength, and the quantity required for that purpose accurately noticed. This gave the proportion of *free* acid present, and by adding this to the quantity in union with a fixed alkali, as determined above, and subtracting the sum from the *total* quantity of muriatic acid present, the proportion of acid in union with *ammonia* was estimated. But as a check to this result the third neutralized portion above mentioned was evaporated to dryness, and the muriate of ammonia expelled by heat and collected. The quantity of muriatic acid this contained was then determined as before, and was always found to represent nearly the quantity of muriate of ammonia as before estimated; thus proving the general accuracy of the whole experiments beyond a doubt. 4. The remaining fourth portion of the original fluid was reserved for miscellaneous experiments, and particularly for the purpose of ascertaining whether it contained any other acid besides the muriatic. The experiments above mentioned seemed to preclude the possibility of the presence of any destructible acid, and the only known fixed acids likely to be present were the sulphuric and phosphoric; the muriate of barytes, however, neither alone nor with the addition of ammonia produced any immediate precipitate *, shewing the absence of these two acids in any sensible quantity, and still farther confirming the results as before obtained.

"In this manner the three following results, selected from a variety of others of a similar nature were obtained:

* It may be proper to remark, that ammonia after some time caused a flocculent precipitate, consisting of the earthy phosphates in union with vegetable and animal matter, and that after combustion traces of sulphuric acid, the result of that process, were very perceptible. But it is evident, from the experiment related in the text, that neither of these acids previously existed in the original fluid in a free state.

	No. I. Grains.	No. II. Grains.	No. III. Grains.
Muriatic acid in union with a fixed alkali* . . .	.12	.95	1.71
——— with ammonia	1.56	.76	.40
——— in a free or unsaturated state . .	1.59	2.22	2.72
Total	3.27	3.93	4.83

These results then seem to demonstrate that free, or at least unsaturated, muriatic acid in no small quantity exists in the stomach of these animals during the digestive process; and I have ascertained, in a general manner, that the same is the case in the stomach of the hare, the horse, the calf, and the dog. I have also uniformly found free muriatic acid in great abundance in the acid fluids ejected from the human stomach in severe cases of dyspepsia, as the following examples shew. The original quantities of the fluid operated on of course were various but for the sake of comparison they are reduced in the following table to one pint, or sixteen fluid ounces, which quantity, in three instances selected from many others, was found to contain, of

	No. I. Grains.	No. II. Grains.	No. III. Grains.
Muriatic acid in union with fixed alkali † . . .	12.11	12.40	11.25
——— with ammonia	0.00	0.00	5.39
——— in a free or unsaturated state . . .	5.13	4.63	4 28
Total	17.24	17.03	20.92

* For the sake of analogy, the chlorine, in union with the basis of the *fixed* alkali, is reduced in this table and the following to the state of muriatic acid.

† I have never in more than one instance, (No. 3, of the above table) been able to detect any sensible quantity of the muriate of ammonia in the fluids ejected from the human stomach; and upon enquiry of Sir Astley Cooper, who was kind enough to furnish me with the fluid for examination, I was informed that the patient was in the habit of frequently taking ammonia as a medicine.' —Pp. 46—49.

Art. XII. Selections from Foreign Science.

I. *Researches on the Sulphuric Acid of Nordhausen, by* M. Bussy.

The Society of Pharmacy of Paris proposed various questions relating to this acid as the subject of a prize; most of which have been well answered by the researches of M. Bussy, of which the following is an account:

The first question related to the *true nature of the Sulphuric Acid of Nordhausen.* This acid as it exists in commerce is brown, of a variable density, not much different from that of common sulphuric acid, having a decided odour of sulphurous acid, and giving off white suffocating vapours in the air. If heated, it boils at 100° or 120° Fahr.; and by degrees one part evaporates in dense vapours, the remainder ceases boiling, becomes colourless, and is common sulphuric acid. A portion of the fuming acid was put into a tubulated retort, the beak of which had been considerably lengthened and drawn out in the lamp, and contracted at the aperture: the extremity was introduced into a long narrow tube closed at one end and serving for a receiver: this arrangement was made to avoid the use of corks, and the access of the atmosphere. The tube was then cooled by ice, and the acid heated; it soon boiled, the tube became filled with vapours which condensed into a solid mass having the following properties: it was opaque, white, solid, difficult to cut, and fuming in the air; left in the air it deliquesced and became like oil of vitriol; it charred vegetable substances, as paper, *&c.;* and when put into water dissolved with a hissing noise, producing an acid solution with all the characters of diluted sulphuric acid.

These characters seemed to indicate concrete sulphuric acid: in order to ascertain whether water caused the liberation of any gas, the substances were mixed in a tube over mercury, but no gas was liberated. It was then combined directly with a base, being sublimed from the tube in which it was received, over caustic baryta placed in a second tube and heated: great incandescence was produced by the combination, but no liberation of gas; on the contrary, the mercury which closed the apparatus was pressed inwards. When the action was over, the barytes was taken out and digested in muriatic acid; it liberated neither sulphurous acid gas nor sulphuretted hydrogen; it merely dissolved the excess of baryta, and left a true sulphate of baryta. It follows, therefore, that the concrete acid was pure sulphuric acid, and that no sulphurous acid was present: all that can be supposed, is the presence of a little water, and this would be detected by a similar experiment made with known quantities of the substances. Much care was found requisite in making this experiment, espe-

cially whilst weighing the acid, on washing out the sulphate formed, in moderating the intensity of heat during the combination, *&c.* The mean of three experiments gave, for 1 of acid operated upon, 2.886 of sulphate of baryta, which being equivalent to .992 of dry acid, gives a deficiency of 0.008, so that the acid cannot contain more than this quantity of water: but, as it is difficult to make the experiment exactly, and every error would involve a loss of this kind, and moreover, as it is not at all a probable proportion of water, there is every reason to believe that the solid substance which may be obtained by sublimation from the fuming acid of Nordhausen, is dry sulphuric acid.

The following are the properties of this substance: it is solid or liquid according to the temperature, and when liquid is more fluid than common sulphuric acid; it is highly refractive; its specific gravity is 1.97, at 68° Fahr. It remains fluid at 77° Fahr., but below that point silky crystals form, and ultimately the whole becomes solid. Once solid it is difficult to fuse, because the first portions heated become vapour and propel the rest forward; but by slight pressure this is prevented. When solid it is white, opaque, fuming in the air, and deliquescent. It dissolves sulphur, forming brown, green, or blue compounds, according to the quantity taken up: when water is added, the sulphur is deposited. Iodine dissolved in it forms a bluish-green solution.

Nordhausen acid is therefore essentially a mixture of common and anhydrous sulphuric acid: the sulphurous acid which it contains, though constantly produced in the process of its preparation, confers no particular properties on it; and the brown colour is entirely accidental.

M. Bussy then proceeds to examine the action of heat on sulphate of iron, that being the well-known process by which the fuming acid is obtained. When crystallized sulphate of iron is heated, it first loses about 45 per cent. of water and becomes anhydrous; sulphurous acid is then evolved, and ultimately very dense suffocating vapours. The latter act upon mercury, and therefore cannot be received over it without previous washing; but, when passed through water, and then received over mercury in separate portions, it was found that though at first sulphurous acid gas only came over, oxygen soon appeared, which increased in proportion, until ultimately the gas was a mixture of two volumes of sulphurous acid gas, and one of oxygen. The washing water contained sulphuric acid, and the retort peroxide of iron with a little sulphuric acid. Hence it appears, that at first sulphuric acid was decomposed peroxidizing the iron, and liberating sulphurous acid; that then one portion of sulphuric acid rose without decomposition, and was retained by the water, whilst another portion was decomposed by the heat, and produced the mixture of sulphurous acid gas and oxygen. It was probable

from this that decomposition to a smaller extent would take place if persulphate of iron were used; and, on trying the experiment the sulphurous acid and oxygen came over from the first in the proportions of 2 and 1, and the sulphuric acid condensed in the water.

To ascertain whether the water had any influence in *forming* sulphuric acid from the vapours, it was now removed, and in its place was put a small dry flask, cooled by a mixture of ice and salt. The distillation was made as before, oxygen came over during the whole time, but scarcely any sulphurous acid, and very few white vapours. When the apparatus was taken down, a colourless transparent liquid was found in the matrass, emitting abundance of white vapours, which exposed to the air partly evaporated; and the rest formed crystals, at first opaque, then becoming transparent, and finally a liquid, or common sulphuric acid. When the liquid was left in an open vessel to which the air had not free access it sublimed, resembling benzoic acid in appearance; put to water it caused explosions, liberating sulphurous acid gas, and giving solution of sulphuric acid; concentrated sulphuric acid caused the evolution of sulphurous acid, but added cautiously in small quantities, transparent crystals were obtained. Finally, on passing this acid over baryta, sulphate and sulphuret of baryta were formed.

At first hyposulphuric acid was suspected, but it was soon found that the liquid was a mere mixture of sulphuric and sulphurous acid: when it was distilled it boiled at about 25° Fahr. for a short time, but it was soon requisite to raise the temperature; and the portion which first came off when condensed was found to be pure liquid sulphurous acid, whilst what remained in the retort crystallized, and proved to be anhydrous sulphuric acid. To put this conclusion beyond doubt, it was only necessary to ascertain whether sulphurous acid gas alone would condense by cold, and this was found to be the case *.

Alum and all the sulphates decomposable by heat gave similar results. When the salts are not quite dry less liquid is obtained, and crystals of an hydrated acid are formed in the neck of the retort; but it is always easy to obtain a product free from water, by letting the first portions of the produce pass away; and indeed, the receiver should never be adopted before the white suffocating vapours pass in great abundance.

The instantaneous solution of indigo by the fuming acid obtained from the sulphates is a very remarkable property; but the solution obtained, unlike that made with the common sulphuric acid, is of a

* See our last Number, p. 391. M. Bussy's experiment is a remarkable confirmation of what Monge and Clouet did, even almost to the degree they mention. See *Quarterly Journal,* XVI. p. 234.

very fine purple colour, exactly like that of the vapours of indigo. This property belongs to the pure anhydrous sulphuric acid, which alone will dissolve the indigo in a similar manner, whilst anhydrous sulphurous acid has no action upon it. When the purple solution is exposed to the air, or when water or common sulphuric acid is added to it, it becomes blue though always retaining a trace of purple. M. Bussy concludes, that in the purple solution the indigo is more finely divided than in the blue solutions, and that for the same reason the vapour appears purple, that being the true colour of the substance.

Finally, with reference to the method of obtaining the fuming acid of Saxony: as it differs from common acid only in containing less water, it is evident it may be obtained in all proportions. Some dry persulphate of iron was distilled in a coated glass retort, and the produce received in distilled water; it gave an acid of specific gravity 1.16; this was repeated several times with the same portion of liquid, and ultimately it became very fuming sulphuric acid. It is, however, evident, that it would be far more economical to receive the produce of the distillation of persulphate of iron at once into acid of the specific gravity 1.848.

That processes for the preparation of this acid in the large way may be successful, it is requisite to multiply the points of contact between the liquid acid and that in vapour. The vapours should pass by a small orifice. M. Bussy joined to his retort an adapter, with the extremity drawn out; to this was joined a glass balloon with a pointed tube, and to that a second, tubulated. The acid to be saturated was then divided between these vessels, and in this manner about 4lb. 7oz. of dried sulphate of iron converted 1lb. $10\frac{1}{2}$oz. of common sulphuric acid into 2lb. $3\frac{1}{4}$oz. of very fuming acid.

When the acid is made as concentrated as possible, it crystallizes at common temperatures. The specific gravity of these crystals could not be taken, but that of the liquid about them was 1.907, and this M. Bussy thinks was not so high as the pure sulphuric acid would have had, for it was ascertained by direct experiment that sulphurous acid added to sulphuric acid, diminished its density. This effect influences materially the specific gravity of the Nordhausen acid which may vary from 1.848 to 1.896.

M. Bussy's results are, 1. That Nordhausen sulphuric acid is only common sulphuric acid, containing a certain quantity of anhydrous acid to which it owes its properties; and that the sulphurous acid is accidental, and has no important influence. 2. That this anhydrous acid may be separated by distillation, and that it has among other remarkable properties, that of making a red solution of indigo. 3. That all those sulphates which are decomposed by heat give oxygen, sulphurous acid, and sulphuric acid, which is essentially characterized by the white vapours pro-

duced during the decomposition. 4. That all these sulphates may be used in the preparation of the common or the fuming sulphuric acid by means of the process described.—*Jour. de Phar.* x. 368.

II. *On the Re-action of Sulphuret of Carbon and Ammonia; on the Combinations which result, and particularly a New Class of Sulpho-cyanurets.* *By* M. W. C. Zeise *.

When sulphuret of carbon is added to alcohol containing ammonia in solution, the effects are very different to those produced by the use of potash or soda: no hydroxanthate is obtained, but at least two other salts are produced; the one containing a new acid, which may be considered as formed of sulphocyanic acid and sulphuretted hydrogen; the other as containing a double sulphuret of hydrogen and carbon. The ammonia, therefore, as well as the sulphuret of carbon is decomposed during the action.

Preliminary Observations on the Mutual Action of these two Bodies.—1. Sulphuret of carbon dissolves abundantly in alcoholic solution of ammoniacal gas, producing a liquor which at first resembles that produced when potash is used as the alcali; but evidently differing in the impossibility of rendering the solution neutral, however much of the sulphuret is used, and in the circumstance that after a short time the odour of sulphuretted hydrogen is produced.

2. If from 15 to 17 measures of sulphuret of carbon, 45 of alcohol, and 100 of alcohol saturated with ammoniacal gas, are put into a wide-mouthed flask of such a size as nearly to fill it, the flask well closed with a glass stopper, and left at a temperature of from 54° to 57° Fahr., in about 10 minutes the liquor will become yellow, and in 20, brown. Shortly a multitude of plumose crystals will form at the bottom, and a substance of the same kind will adhere to the stopper and uncovered parts of the flask. The quantity will increase for above an hour, after which a new crystallization will commence, proceeding much slower; the crystals will group more distinctly, frequently in stars; they are of a different colour to the first crystals, more brilliant, more perfect in form, and prismatic. After 30 or 40 hours this formation will cease, the crystals will sometimes be half an inch in length, and the quantity considerable; at the same time the first crystals will have decreased in quantity, and perhaps even have disappeared entirely. The first salt is a combination of the double sulphuret of carbon and hydrogen with ammonia, and may be distinguished as the *reddening salt*: the second was distinguished as a *hydrosulphuretted hydrosulphocyanate of ammonia.*

* See *Quarterly Journal,* XIV. 433. XV. 301.

3. The liquid over the crystals, smelling strongly of hydrosulphuret of ammonia, when carefully distilled yields a brownish liquid, with a yellow crystalline solid body consisting of the reddening salt and hydrosulphuret of ammonia, which when it amounts to one-third leaves in the retort a colourless liquid, that upon cooling deposits long yellowish-white acicular crystals, these being sulphur mixed with a little sulphuret of cyanogen.

4. Decanting the liquor from the latter, and re-distilling until but little fluid is left, on cooling a spongy lamellated white substance is deposited, and more of the same substance is dissolved in the mother water. This substance dissolves readily in water, and on examination proved to be the sulphocyanate of ammonia of M. Porret.

5. If the liquid over the crystals in the flask, instead of being distilled, be exposed to air, it loses colour, and in 24 or 30 hours deposits voluminous crystals of sulphur mixed with a little hyposulphate of ammonia, after which it contains the usual sulphocyanate of ammonia.

On the Reddening Salt, or Hydrocarbosulphuret of Ammonia.

6. This salt is obtained in great quantity by using the sulphuret of carbon and ammoniacal solution in the proportions before-mentioned, *without* the addition of the pure alcohol, and submitting the mixture, when made, to temperatures from 39° to 43° Fahr., but it then forms only a crystalline powder; in about three quarters of an hour the liquor is to be decanted, and the salt carefully washed with pure alcohol.

7. The salt is at first of a light yellow colour, but reddens very rapidly by contact with the air, becoming at the same time moist and slowly evaporating; it is principally the water of the air which produces the change of colour. It is hardly possible to dry the salt by bibulous paper without its becoming red, unless the alcohol be removed from it previously by washing with ether; and then by compression in paper it may be dried, and will bear the contact of air without alteration for five or six minutes. The salt is always alkaline, but exposure to air increases the ammoniacal odour. Water dissolves it entirely and readily, producing a brown-red solution, unless very dilute, when it appears yellow. It is slightly soluble in alcohol.

8. The solution in water treated with sulphuric or muriatic acid loses its colour, liberates sulphuretted hydrogen, and after some time becomes turbid as if from a little sulphur, but more acid restores limpidity. No sulphurous odour was perceived even when the solution was precipitated by a metallic salt before adding the acid; from which it results, that it *contains no hyposulphurous acid.* It contains *no carbonic acid,* for salts of lime or baryta do not precipitate it. It produces a red precipitate with salts of lead;

brown with salts of copper; yellow with corrosive sublimate. All these precipitates change gradually; that of lead becomes black, and diminishes in bulk to a powder, which has the properties of sulphuret of lead, and at the same time *sulphuret of carbon* separates. The change is produced without access of air. When the precipitate is rapidly dried by the air-pump, and then heated in a bent tube, sulphuret of carbon rises leaving sulphuret of lead. Hence it may be concluded that these metallic precipitates are formed of metallic sulphurets and sulphuret of carbon; from whence it follows that the reddening salt may be considered as a *compound of ammonia, and a double sulphuret of hydrogen and carbon.* It contains no sulphuretted cyanogen, for when precipitated by nitrate of lead the remaining solution does not, when tested by a per-salt of iron, indicate sulphocyanic acid; but, if the salt of ammonia be previously heated with solution of potash, abundance of sulphocyanic acid is formed.

9. The *double sulphuret* may be separated from the reddening salt, by throwing a mass of the latter into sulphuric or muriatic acid, but little diluted, and then adding a sufficient quantity of water. The double sulphuret is obtained, with scarcely any liberation of sulphuretted hydrogen, as a reddish-brown oil heavier than the fluid about it; but the process does not always easily succeed. This substance differs in its odour from sulphuretted hydrogen: it cannot be preserved long, so that its examination when pure is difficult, but when separated from the acid about it as much as possible, it may be seen that in contact with carbonate of baryta under water there was an immediate effervescence; a soluble substance is obtained, which M. Zeise considers as a compound of sulphuret of barium and sulphuret of carbon, and which is very alkaline, although carbonate of baryta was used.

10. The reddening salt, confined with alcohol in a close vessel, becomes in 30 or 40 hours *sulphuretted hydrogen, and hydrosulphuretted hydro-sulphocyanate of ammonia.*

Hydrosulphuretted Hydrosulphocyanate of Ammonia.

11. The proportions first stated are proper for the preparation of this compound: the liquor is to be left on the first-formed crystals until the second set begin to appear, generally about two hours, at 60° Fahr.: it is then to be poured off, filtered rapidly through paper moistened with alcohol, and left in a closed wide-mouthed flask for ten hours, at about 50° Fahr.; cooling the liquor too suddenly sometimes causes the formation of a little of the reddening salt; but towards the end of the crystallization it is well to lower the temperature. After thirty hours, decant, wash the broken crystals with small portions of alcohol, put the salt on dry paper, and compress it powerfully. If the salt is to be preserved, finish the drying by an air-pump.

12. Though generally of a clear colour it is sometimes obtained of a deeper tint.

13. When recent it is nearly without odour, but when left in moist air, for two or three hours, it has a faint smell of hydrosulphuret of ammonia; and if the air be very damp it softens a little. It dissolves abundantly in water, not so readily in cold alcohol, but very readily at high temperatures. Ether dissolves but little, naphtha none. The aqueous solution is, when strong, yellow, when dilute, colourless.

14. It has all the characters of a neutral salt, except when by time it smells of sulphuretted hydrogen, and then it becomes alkaline. Acids produce no effervescence with it, except they become decomposed, as nitric acid; nor do they cause immediate precipitates. Salts of lime and baryta cause no precipitate. Persalts of copper, a flocculent yellow precipitate, not undergoing change by time or air; dilute nitrate of silver, yellow becoming black; salts of lead and mercury, white precipitates becoming black; with per-salt of iron, the solutions become black, and give a black precipitate which becomes white.

15. The yellow precipitate from copper, heated with a solution of potash, neutralized it, furnishing the usual hydrosulphocyanate of potash of Porret, and depositing a black powder, which examined by heating in a tube, *&c.*, proved to be deutosulphuret of copper. When boiled in water only, the same effect takes place, and the copper precipitate gradually produces solution of hydrosulphocyanic acid and the deutosulphuret of copper. Hence it appears that the yellow precipitate may be considered as a compound of deutosulphuret of copper and hydrosulphocyanic acid, and for reasons advanced, or to be advanced, M. Zeise considers it as a compound of one proportional of the sulphuret, and two of the acid; and consequently the ammoniacal salt from which it was formed, as one ammonia, one hydrosulphocyanic acid, with two hydrogen and one sulphur.

16. The solution of the salt does not change, except when exposed to the air, when it deposits crystals of sulphur, and becomes common hydrosulphocyanate; the oxygen of the air appearing to have taken hydrogen, and set sulphur free: sometimes also it becomes slightly acid. An alcoholic solution of the salt, when heated, is decomposed, and hydrosulphuret of ammonia set free. The solid salt also, by lime, appears to form a little hydrosulphocyanate.

17. Sulphuric or muriatic acid diluted with two parts of water, added to a solution of one part of the salt in four of water, and then mixed with much more water, causes the separation of a translucid, colourless, and oleaginous fluid at the bottom of the mixture, which may be preserved some time therein, but not in pure water; and which may probably be the *hydrosulphuretted*

hydrosulphocyanic acid. Strong sulphuric acid, added to the solid salt, yields a white fatty-looking substance, not dissolving in water, but decomposed by it. Diluted acid added to diluted solution of the salt, after a time causes a turbidness with some peculiar appearances; when considerably diluted, after standing some time, sulphuret of carbon was deposited. If a salt of peroxide of iron were added before the turbidness came on, then a multitude of small white crystalline scales were formed.

18. Some of the solid salt of ammonia, heated in a small retort up to 140° Fahr., fused with effervescence, emitting gas and vapours, the latter condensing in the receiver at 300° Fahr.; this evolution was very rapid: after some time, raising the heat to 392° Fahr. the fused portion became brown; the liberation of volatile matter diminished; the substance became solid, so that, at last, although red hot, a greyish-yellow solid body was left. The contents of the receiver, were, the reddening salt before described, and a white substance, probably hydrocyanate of ammonia. There was no sulphate or carbonate, from which it may be concluded that the salt contained no water. The gas was sulphuretted hydrogen, doubtless mixed with cyanogen and nitrogen. There was no odour like that produced by distilling the hydroxanthates.

19. The yellow mass, bearing a high temperature, cannot be sulphur, but a peculiar compound. Boiled with solution of potash it is but slightly attacked; but evaporated to dryness, heated, and then acted on by water, it gives the common hydrosulphocyanate of potash; it must therefore contain sulphur, carbon, and hydrogen, (nitrogen?) It inflames with difficulty, producing sulphurous acid; heated considerably, without access of air, one part is destroyed, whilst another sublimes without change. Water, alcohol, sulphuret of carbon, or muriatic acid, have no action on it. Boiling nitric acid acts on it slowly, and sulphuric acid seems to soften and dissolve it.

Combinations of Bases obtained from this Salt.

20. As before mentioned, solution of copper gives a precipitate of a pale-yellow colour, which should be washed with cold water. The precipitate does not separate readily, until the whole of the ammoniacal salt is decomposed. The precipitate by nitrate of lead is re-dissolved by excess of the nitrate.—21. The precipitates of copper and mercury, heated out of contact with the air, became black, and a substance sublimed which became a yellow-coloured solid: cinnabar also rose from the mercury; a sulphuret remained from the copper precipitate, and a portion of substance like that described (19) was produced.—22. As to the composition of the lead and mercury precipitates, it is, without doubt, analogous to that of the copper precipitate, a compound of the metallic sulphu-

ret with the common hydrosulphocyanic acid.—23. Sulphate of zinc added to the salt in excess caused the gradual formation of a white precipitate, and after some days, of pyramidal crystals of an olive-green colour. Treated with potash these crystals gave oxide of zinc and hydrosulpuretted hydrosulphocyanate of potash.

24. The ammoniacal salt decomposed by potash, lime, and baryta, gave compounds of these bases, with the peculiar acid. Some difficulty attends the conversion in preventing decomposition. Some of the ammoniacal salt in solution was mixed with a portion of solution of potash, insufficient to decompose the whole of it; the mixture, slightly heated, was put with sulphuric acid under the air-pump to remove the free ammonia. After some time, the liquor, no longer alkaline, was mixed with a fresh quantity of potash, and treated as before; and this was repeated until it became permanently alkaline, when a little more of the ammoniacal salt was added, and the operation finished by the air-pump. This solution, by evaporation in the air-pump, gave a saline crystalline mass, readily soluble in water and alcohol, it being a true hydrosulphuretted hydrosulphocyanate of potash. The aqueous solution, heated, deposited sulphur, and became common hydrosulphocyanate of potash. The alcoholic solution, left in a vessel imperfectly closed, underwent the same change.

26. Similar preparations of lime and baryta were made; the excess of lime was removed by alcohol, the excess of baryta by carbonic acid; the alcoholic solution of the calcareous compound, evaporated in the air-pump, gave a substance in appearance like gum.

Crystallized Hydrosulphuret of Cyanogen.

27. The phenomena appearing by the use of salts of iron, (14 and 17,) were then particularly referred to. The white substance there mentioned is best obtained by dissolving one part of the ammoniacal salt in 180 parts of water, and adding a mixture of one sulphuric or muriatic acid to sixteen of water, until the whole is strongly acid. Immediately a solution of persulphate or muriate of iron is to be added in small portions; the liquor darkening at first, soon becomes colourless, and a large quantity of white crystalline scales form, and are deposited. If too much salt of iron be added, so as to cause a permanent red colour, the precipitate is of a yellow tint.

29. This substance contains no iron, but is a *particular compound of sulphur, carbon, nitrogen, and hydrogen*, containing probably more sulphur and less hydrogen than the acid of the salt which furnished it. When perfectly pure it is white as snow, and in the form of shining scales; it has scarcely any odour, and does not change remarkably by contact with air. Hot water decomposes it, producing common hydrosulphocyanic acid. It dissolves

in alcohol, the solution slightly reddens litmus paper, and becomes turbid by water. Nitro-muriatic acid slowly decomposes it, and the solutions are not precipitated by alkalis. It does not combine directly with either ammonia or potash. When boiled with potash, the yellow solution formed smells strongly of sulphuretted hydrogen; precipitates salt of lead, partly black, partly red; and when completely precipitated by nitrate of lead, still yields an intense red colour with salts of iron. Cold solution of potash acts in a manner somewhat similar. When the white crystalline matter is submitted to an increasing heat it gives sulphuretted hydrogen, the reddening salt, and the yellow substance spoken of (19.)

The colourless liquor in which the crystalline matter was formed, when exposed to air, gradually reddens. The salts of protoxide of iron, do not produce the crystalline matter, except after long contact with the air.

From all this, says M. Zeise, it appears probable that this substance is formed in the following manner: Two atoms of the hydro-sulphuretted hydrosulphocyanic acid, deprived by the peroxide of iron of a portion of hydrogen (probably two atoms,) are divided into an atom of common hydrosulphocyanic acid and an atom of crystallized hydro-sulphuretted cyanogen; whilst the protoxide of iron thus formed and combined with the hydrosulphocyanic acid remains in solution: from which it readily appears that the crystalline substance should contain less hydrogen and more sulphur than the hydro-sulphuretted hydrosulphocyanic acid. It is probably a compound of 1 nitrogen, 2 carbon, 4 sulphur, 4 hydrogen.

M. Zeise then remarks on the sulphuretted hydrosulphocyanic acid of M. Woehler, which appears to contain 4 atoms of sulphur to 2 of hydrogen. This acid is formed, according to M. Woehler, by exposing the sulphuretted cyanate of mercury to the action of either sulphuretted hydrogen or muriatic acid gas; or by treating the common hydrosulphocyanate of potash by weak nitric acid; or by exposing the same salt to the action of the voltaic pile. In all these cases an amorphous orange-yellow body is produced, which is not sulphur, but a particular compound of sulphur, carbon, nitrogen, and hydrogen.

This body is very different from the white crystalline matter just described. When in contact with solution of potash it deepens in colour, and when again freed from the potash it becomes, on the addition of water, of a ruby colour, giving a reddish-yellow solution, which precipitates salts of lead of a fine yellow. In all these properties it is very different to the white crystalline matter described.—*Ann. de Chim.* xxvi. 66, 113.

Such are the facts contained in the first part of M. Zeise's important memoir. They are followed by some very ingenious rea-

sonings on the composition of some of these bodies, to which we shall take an opportunity of returning.

III. *Fluoric Acid.*

[Extract from a Letter from M. BERZELIUS to M. DULONG.]

"I have examined the combinations of fluoric acid with bases, and have found that what have been taken for fluates are only double salts. I have analyzed fluo-silicic gas and its combination with bases; all these compounds are formed in the same manner, and contain a quantity of fluoric acid combined with the silica, twice as much as that combined with the base. Fluoric acid gives analogous combinations with the acids of titanium, tantalium, tungsten, molybdenum, chromium, selenium, antimony, and arsenic, also with the hyposulphurous and sulphurous acids, and probably with the phosphorous and hypophosphorous acids, though I have not examined these last.

"Fluoric acid is a most convenient agent in the analysis of inorganic substances, as it dissolves all those substances which other acids will not attack. It has furnished me with the means of determining the exact atomic weight of many substances on which I still had doubts. To extract the alkali of minerals it is sufficient to treat them with fluoric acid, or with a mixture of fluate of lime and sulphuric acid." —*Ann. de Chim.* xxvi. 40.

IV. *Silicium and Zirconium.*

[From M. BERZELIUS' Letter to M. DULONG.]

"In trying to reduce fluoric acid by potassium, I succeeded in reducing silica, zirconia, and the other earths, but I have only been able to separate silicium and zirconium. The others decompose water with the greatest energy. Pure silicium is incombustible even in oxygen gas. Water, nitric acid, or nitro-muriatic acid, do not attack it, nor does caustic potash; but fluoric acid dissolves it a little, especially if nitric acid be added. It does not decompose nitre, except at a very intense heat, but it detonates with carbonate of potash at a dull red heat; carbonic oxide gas is liberated, and carbon is set at liberty. When it is heated with nitre, if a small piece of dry carbonate of soda is introduced into the mixture there is immediate detonation. When the vapour of sulphur is passed over silicium heated to redness, the metal quickly becomes incandescent. When the combination is perfect, which seldom happens, the substance is in the form of a white earthy mass, and decomposes water with great rapidity. The silica is dissolved, and sulphuretted hydrogen gas liberated. By this means a solution of silica in water may be obtained, so concentrated, that

during evaporation it thickens, coagulates, and deposits portions of the earth, in the form of gummy transparent masses. The siliciuret of potassium, heated with sulphur, burns vividly, and when dissolved leaves the pure silicium. Silicium takes fire in chlorine at a red heat, and a liquid results, colourless, or of a light-yellow colour, of an odour resembling that of cyanogen, very volatile, and which, with water, congeals, and deposits gelatinous silica. I have not as yet examined its conducting power for electricity and heat, its specific gravity, &c.

"Nothing is easier than to procure this substance; the following is the mode I have ultimately adopted: The double fluate of silica with potash or soda, heated almost to redness to drive off hygrometric water, is introduced into a glass tube, closed at one extremity; pieces of potassium are then to be introduced, and the metal carefully mixed with the powder, by heating it till it fuses, and then lightly striking the tube. It is then to be farther heated by a lamp, and before it attains a red heat there is a slight detonation, and the silicium is reduced. The mass is to be cooled, and then washed with water as long as any thing dissolves. There is at first disengagement of hydrogen gas, because a portion of siliciuret of potassium has been formed, which cannot exist in contact with water. The washed substance is a hydruret of silicium, which at a red heat burns vividly in oxygen gas, although the silicium is not completely oxidized; it is to be heated in a covered platinum crucible, slowly augmenting the fire to redness; the hydrogen only oxidizes, and the silicium will no longer burn in oxygen gas; though chlorine attacks it very easily. The little silica produced may be removed by fluoric acid, but if the silicium has not been strongly heated, the acid will dissolve a little of it, with the disengagement of hydrogen. According to the synthetical experiments which I have made, silica contains about 0.52 of its weight of oxygen.

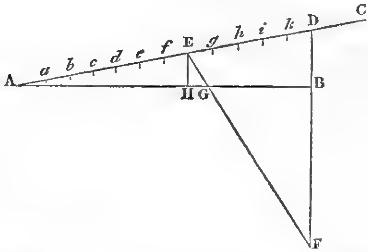
"Zirconium is obtained in an analogous manner. It is as black as carbon, does not oxidate in water or in muriatic acid, but nitromuriatic and fluoric acids dissolve it, the last with the disengagement of hydrogen. At a temperature but slightly elevated it burns with great intensity. It combines with sulphur. Its sulphuret is of a chestnut-brown colour like silicium, and insoluble in muriatic acid or the alkalis. It burns with brilliancy, producing sulphurous acid gas and zirconia."—*Ann. de Chim.* xxvi. 41.

V. *Division of a Right Line, by* M. Voruz.

The following new geometrical process for the division of a right line into any number of equal parts is by M. Voruz, Principal of the College of Moudon, Canton de Vaud, who, in his letter to the editors of the *Bib. Univ.* says, that although the subject is very

elementary, yet the frequent occasion to divide a right line, and above all, the singularity of the result at which he had arrived, seemed sufficient to excite the curiosity of the lovers of mathematics.

Problem. *To divide a right line into any number of equal parts.* Let AB. fig. 1. be the line given to be divided into equal parts:

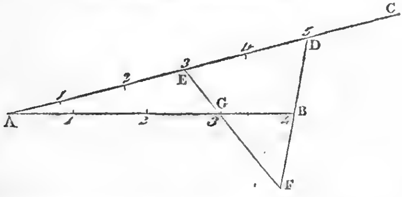


from its extremity A, extend at any angle the indefinite line Ac, on which are to be laid down the equal parts Aa, ab, bc, &c. of an arbitrary length: let m be the number of parts from A to D; join the points D and B by the line DB. prolonged towards F, so that $BF = BD \times n$ (n being any number whatever, whole or fractional.) Then join the point F with the extremity E of any one of the parts on AC, and suppose that AE contains l parts, then ED will contain $(m-l)$ of these parts.

To ascertain in what manner the line AB is divided at G by EF, draw EH parallel to DF, which will give BH : AB :: DE : AD :: $(m-l) : m$; from which $BH = \frac{AB\,(m-l)}{m}$. But because of the similar triangle AEH, ADB, EH : BD :: AE : AD :: $l : m$, and from which $EH = \frac{BD.\,l}{m}$; but as by the construction $BF = BD \times n$, and consequently $BD = \frac{BF}{n}$ by substituting this value for BD, EH will equal $\frac{BF.\,l}{mn}$. In consequence of the similarity of the triangles BGF, EGH, BF : EH :: BG : HG, or, which is the same thing, BF : $\frac{BF.\,l}{mn}$ :: BG : HG. Dividing the two terms of the first ratio by FB, and then dividing them by mn, the proportion will become BG : HG :: $mn : l$, from which it follows that (BG + HG) : BG :: $(mn + l) : mn$, or BH : BG :: $(mn + l) : mn$. Substituting in

this last proportion the value of BH found above, we shall have $\frac{AB\,(m-l)}{m}$: BG :: $(mn + l)$: mn. Obtaining from this proportion the value of BG, which is expressed by AB and the known quantities m, n, l, we shall have $BG = \frac{AB\,(m-l)\,n}{mn-l}$, a formula which indicates the ratio of BG to AB, according to the particular values given to l, m, n.

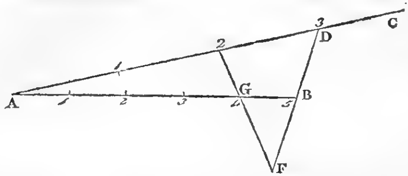
Although in varying the value of n very interesting results may be obtained, I shall confine myself to the examination of the formula in those cases where $n = 1$. as being that which is most conveniently applicable in practice, and in which case $BG = \frac{AB\;(m-l)}{m+l}$. If now it is required to divide AB into 2. 3. 4. 5. or p equal parts, it is evident that to make BG one of those parts we should have generally $\left(\frac{m-l}{m+l}\right) = \frac{1}{p}$, from which may be obtained successively $(m-l)\,p = m + l$, or $mp - lp = m + l$, and by transposition $pm - m = pl + l$, or, which is the same thing, $m(p-1) = l(p+1)$, from whence may be deduced the proportion $m : l :: (p+1) : (p.1)$. On now giving particular values to p, the ratio will be obtained which should exist between m and l for the different cases which may be proposed. It must be remembered here that n has been made equal to 1, *i.e.*, that the line BD is to be extended by a quantity equal to its own. To illustrate what has been said by an example, let it be proposed to divide the line AB, fig. 2, into four equal parts. The proportion $m : l :: (p+1) : (p-1)$ becomes, by making $p = 4$, $m : l :: 5 : 3$, so



that five equal parts must be laid down on AC, and from the extremity F of the line DF = 2 DB a right line must be drawn to the extremity of the third part on the line AC, which right line will divide AB at G, GB being equal to a fourth part of the whole.

When AB is to be divided into an unequal number of parts, and consequently $(p + 1)$ and $(p-1)$ are both even numbers, the ratio of m to l may be simplified by dividing $(p + 1)$ and $(p-1)$ by 2.

If it were wished to divide the line AB, fig. 3, into five equal parts,



the proportion $m : l :: (p + 1) : (p - l)$ would become $m : l :: 6 : 4$, or $m : l :: 3 : 2$; hence three parts may be laid down in AC, and a line drawn from F to the extremity of the second part will divide BA in G, giving BG = to the fifth part of AB.

The method above detailed, of dividing a line into any number of equal parts, appears to me to have some advantages over those generally given, inasmuch as it is more expeditious, and does not require the construction of parallel lines, which may easily introduce graphical errors.—*Bib. Univ.* xxvi. 3.

Art. XIII.—MISCELLANEOUS INTELLIGENCE.

Mechanical Science.

1. *On the Action of Iron in Motion on Tempered Steel, by* MM. Darier and Colladon.—The manner in which steel is cut by soft iron, as acertained by Mr. Barnes, has been pointed out, p. 155 of our last Volume; and since then the effect has been attributed to the softening of the steel at the point of contact by the heat resulting from the friction. The following experiments and results in relation to this subject are extracted from a mémoire published in the *Bib. Univ.* xxv. p. 283.

The authors of the paper were led to doubt of the sufficiency of the reason above given, by finding on an examination of the iron plate made use of to cut some steel, that its edge was set with small particles of steel, which seen through a lens did not appear as if untempered, and which, when tried with a file, were found as hard as the best tempered steel. Suspecting, therefore, some other cause for the effect, they first endeavoured to ascertain what degree of motion was sufficient, simply to compensate for the power which in ordinary circumstances steel has of cutting iron, and above which iron on the contrary becomes possessed of the power of cutting steel.

The steel employed consisted of gravers, very carefully tempered. The soft iron plate used was 7 inches 5 lines in diameter, and very carefully centred and mounted, so that any required degree

of velocity could be given to it. The time was measured by a temporary pendulum. Whilst the velocity of the iron wheel, measured at its circumference, was less than 34 feet in a second, the graver cut it with the greatest facility, and without any appearance of re-action. At 34 feet 5 inches, the graver did not cut the iron so well, but was itself unaffected. At 34 feet 9 inches, it was slightly attacked, and the iron turnings cut by it were less abundant. At 35 feet 1 inch, the effect of the iron on the steel was very decided. Above this point the difference increased continually with the velocity; and at 70 feet per second only imperceptible portions of iron could be detached, whilst the gravers were attacked with the greatest violence.

Having ascertained the point at which the change in the reciprocal action of iron and steel took place, the next thing was to ascertain whether the softening of the steel was the necessary cause. The wheel was therefore cleared of the particles of steel at its edge, and put into motion with velocities from 40 to 200 feet per second; the gravers were then applied to it for an instant only at a time, and though sensibly attacked by the iron, yet not the slightest softening could be observed*. When preserved wet the effect was the same. When the pressure was strong and continued, then the gravers became hot and were softened; but the fracture of the steel was then very different to the fracture of the tempered portion, and the steel, when applied to the wheel would give way before it, forming a bur: the action of the iron also on it seemed rather diminished than otherwise.

Hence MM. Darier and Colladon conclude that the effect was not due to the softening of the steel; nor, as the wheel was clean, could it be due to the particles of steel adhering to its surface; and they feel inclined to attribute it to the blow only, thinking it easy to conceive that the fragile steel may be broken by the action of the iron, before it can have time to introduce itself between its molecules.

Rock crystal and agate were held to a wheel of soft iron, moving at velocities from 130 to 200 feet per second: the first was acted upon, but the surface produced was unequal and rough; the agate was also acted upon though less powerfully: but it is supposed that this means, even when much greater velocities are used, cannot be applied to the cutting of these or similar substances with advantage; at the same time the effects, though small, confirm the authors in their view of the cause of the phenomenon.

They then quote similar effects known to be due to the force of percussion, as the piercing of a plank by a ball of tallow, the force of liquids, even, when moving with great velocity: when, therefore,

* This reasoning is hardly conclusive, since the particle removed might have been heated, though the neighbouring particles were not.—E.

to an edge of soft iron, moving with the velocity described, hard elastic bodies are applied, as steel, agate, *&c.*, their particles are displaced and torn off, for they cannot move by each other without division; but when a soft body is applied to the wheel, as copper, brass, tin, and even soft steel, then the substance is pressed before the iron, and being ductile rises up in burs.

The iron wheel was replaced by one composed of 4 copper, 1 tin; but this hard and elastic alloy slipped over the bodies presented to it without producing any effect except violent vibrations. A wheel of copper was then used; steel gravers constantly cut this wheel without being touched by it; but when gravers were made of alloys, all harder than copper but softer than steel, the copper wheel immediately attacked them. Hence it appears that a small difference in the hardness of bodies requires for its compensation a much greater one in the velocities. It is remarkable, that though files and springs of steel were applied forcibly for a long time to the copper wheel, moving with extreme rapidity, scarcely any heat was produced; and the same was the case with the substances that were attacked by the wheel. The authors conclude by stating their opinion, that the experiments are sufficient to prove the dependence of the effect upon mere percussion, and that the softening of the steel is an accidental circumstance.

Professor Silliman, on the same subject, remarks, that the effect in question was first described by the Rev. H. Daggett, and was discovered by some mechanists belonging to the sect of shakers. The thinner the pieces of steel the more rapid the effect: when not thicker than a common joiner's saw they were cut almost as rapidly as wood is cut by the saw itself. It is remarked also, that none of the ordinary operations commenced upon cold and hard steel will divide it with so much rapidity as this mode of applying soft iron.

M. Silliman then explains the effect as many others have done, by considering the steel as previously heated and softened and then cut; but he observes that it is not "perfectly clear why even ignited steel should be so easily cut by the impinging of soft iron. No smith probably ever thought of attempting to divide steel by applying an iron tool;" so that whether the steel be considered as hot or cold the effect may be referred, as MM. Darier and Colladon have referred it, to percussion.

2. *Velocity of Sound.*—Results deduced by Dr. Gregory from the experiments made by himself and others on the velocity of sound. *Cambridge Phil. Transactions*, 1824.

i. That sound moves uniformly; at least in a horizontal direction, or one that does not greatly deviate from horizontality.

ii. That the difference in the intensity of a sound make no appreciable difference in its velocity.

iii. Nor consequently does a difference in the instrument from which the sound is emitted.

iv. That wind greatly affects sound in point of *intensity*, and that it affects it also in point of velocity.

v. That when the direction of the wind concurs with that of the sound, the *sum* of their separate velocities gives the *apparent* velocity of sound: when the direction of the wind *opposes* that of the sound the *difference* of the separate velocities must be taken.

vi. That in the case of echoes the velocity of the *reflected* sound is the same as that of the *direct* sound.

vii. That therefore distances may frequently be measured by means of echoes.

viii. That an augmentation of temperature occasions an angmentation of velocity of sound, and *vice versâ*.

The inquiries with regard to the transmission of sound in the atmosphere, which, notwithstanding the curious investigations of Newton, Laplace, Poisson, and others, require the further aid of experiment for satisfactory determination are, I think, the following, viz.,

i. Whether hygrometric changes in the atmosphere have much or little influence on the velocity of sound.

ii. Whether barometric changes in the atmosphere have much or little influence.

iii. Whether, as Muschenbroek conjectured, sound have not different degrees of velocity, at the same temperature, in different regions of the earth? And whether *high* barometric pressure would not be found (even independently of temperature) to produce greater velocities?

iv. Whether, therefore, sound would not pass more slowly between the summits of two mountains than between the bases?

v. Whether sound, independently of the changes in the air's elasticity, move quicker or slower near the earth's surface than at some distance from it? (See Savart's interesting papers on the communication of Sonorous Vibration.)

vi. Whether sound would not employ a longer interval *in passing over a given space, as a mile, vertically upwards*, than in a *horizontal* direction? and if so, would the formulæ which should express the relation of the intervals include more than thermometric and barometric coefficients?

vii. Whether or not the principal of the parallelogram of forces may be employed in estimating the effect of wind upon sound, when their respective velocities do not aid or oppose each other in the same line or nearly so?

viii. Whether those eudiometric qualities generally (whether hitherto detected or not) which affect the elasticity of the air will not proportionally affect the velocity of sound? and if so, how are the modifications to be appreciated?

3. *On the Use of the Tympanum and the External Ear.*—In consequence of very extensive, and apparently, accurate researches on the use and mode of action of the membrane of the tympanum, and the parts of the external ear, M. Savart has been conducted to the following conclusions:

i. That the communication of vibrations by means of the air appears to take place, at least, for small distances, according to the same laws as those which take place in solid bodies.

ii. That it is not necessary to suppose, as has been done, the existence of a particular mechanism, intended to act on the membrane of the tympanum, and make it vibrate in unison with the bodies which affect it, but that it is always so conditioned as to be readily influenced by any number of vibrations.

iii. That its tension does not appear to vary except to augment or diminish the amplitude of its vibrations, as Bichat has already supposed; but that his opinion is the reverse of the result of experiments, inasmuch as he imagined the tension to be diminished for strong impressions and increased for weak ones.

iv. That the vibrations of the membrane are communicated without alteration to the labyrinth by means of the small bones, as the vibrations of the upper table of an instrument are communicated to the lower table by the intervening piece.

v. That the bones have also the office of modifying the extent of the excursions of the vibrating parts of the organs contained in the labyrinth.

vi. Finally, that the cavity of the drum appears to be intended to preserve an air constant in its physical properties near the apertures of the labyrinth, and against the internal face of the membrane of the tympanum.—*Ann. de Chim.* xxvi. 38.

4. *Temporary Weighing Machines.*—Mr. Bevan suggests the following expedient in those cases where a balance, or proper machine for weighing forces cannot be obtained. If the weight to be found, or force to be measured, does not much exceed twenty pounds, take two pieces of deal, or oak, or any stiff wood, about one inch in diameter and three feet in length, and with a piece of packthread, bind them together at one end for about three or four inches in length; to the other end of one of the rods fasten the weight to be ascertained, or the force to be measured, while the corresponding end of the other rod is securely held: the mutual deflection of the rods by the weight or force may then be measured by a common rule and noted down, and when opportunity serves, the value of the observed deflection may be correctly ascertained by proper weights. If the weight, or force, amount to 80 or 100 pounds, the diameter of the rods should be something more than one inch and a half, or the former rods may be bound together at each end for about two inches, and the deflections

observed at the centre of the rods. An archer's bow also affords a neat temporary instrument for the measuring of weights, or forces, by attaching them to the middle of the string and observing the deflection of the cord from a straight line.—*Tech. Rep.* vi. 196.

5. *Improved Cowl.*—An improvement on the common traversing cowl for the top of chimneys was copied from a French frigate, by Captain Warren, R.N., and found to answer on-board his ship beyond expectation. It is conceived that it might be applied with effect on shore, in situations where inconvenience is occasioned by eddies or high winds. The contrivance is simply inserting a tube, shaped like a speaking trumpet, and open at both ends, into the back of the common cowl so that its wide extremity should form, as it were, the back of the hood, and its narrow extremity terminate a few inches within the mouth. As the wind blows at the cowl, this tube causes a strong jet of air to pass through it, and is found materially to assist the draught of the chimney.—*Mech. Mag.*

6. *Phenomena of Comets.*—M. de Biela, an officer of grenadiers and amateur astronomer at Prague, is said to have observed a remarkable phenomenon in the comet which he first observed on the 30th of December of last year. On the night between the 22d and 23d of January, the comet, besides the tail on the side opposite the sun, had another turned towards the sun. These two tails were not exactly opposite to each other, but formed a very obtuse angle. M. de Biela, who is certain that there was no optical illusion either in the instrument or the eye of the observer, thinks that the most probable explanation of the second tail is, that the comet had left behind it a luminous track in its passage, and that this second tail indicated the path which the comet had just travelled. It was neither so brilliant or so long as the tail opposite to the sun, and was observed only on the 22d, 25th, and 27th of January, neither before nor after.

M. de Biela also conceives that he has observed an influence, exerted by the proximity of comets on the luminous state of the sun, and has traced the increase of spots on its surface as comets have approached that luminary.—*New Monthly Mag.*

7. *Substitution of Potatoes for Soap.*—M. Cadet de Vaux proposes to wash linen by the application of potatoes only three parts boiled instead of soap. The following is an experiment on this subject, made by M. Hericart de Thury, the report of which signed by him has been published.

The linen experimented on consisted of the cloathes of adults and children, sheets, coverlids, table-linen, towels, brewers' aprons, hospital linen, *&c.* The whole was first thrown into a tub to soak in water for about an hour; it was next placed in a copper of hot

water from which the pieces were taken separately to be thoroughly rubbed with the prepared potatoes, as is usual with soap; thus prepared, and after having been well rubbed, rolled and wrung, it was a second time put into the copper with a quantity of the prepared potatoes, and after boiling for half an hour was taken out, turned, thoroughly rubbed, wrung, and again thrown in for some minutes; it was then well rinced twice in a large quantity of water, was put into cold water for half an hour, afterwards into a press to drain, and then hung up to dry. The whole time occupied was about two hours and a half; the linen was perfectly clean, free from all grease, and looked very white.

8. *Preservation of Grain.*—M. le Comte Dejean, concluding that an essential condition for the preservation of grain in quantities, was to prevent air and moisture from having access, has made some experiments, with this object in view, and with the best results. In 1819, he constructed wooden cases, lined with lead, and which, when filled with grain, properly dried, were closed hermetically. At the end of three years, the cases were opened, and the grain found in the most perfect state. M. Sainte Fare Bontemps, who directed the experiments, reported on them, in March 1824; and from his calculations, it appears that the expense of a leaden lining to a case capable of holding 1,250 hectolitres, (about 33,000 wine gallons,) would be, at most, 4,500 francs, and that of a case to contain 10,000 hectolitres, (264,190 wine gallons,) about 18,000 francs. As the grain suffers no loss whilst in the case, and requires no laborious attention, the interest of the capital required would be amply compensated by the advantages of the process. We do not doubt but that, in many circumstances, these cases lined with lead, will be found preferable to magazines constructed in the earth; the preservation of the grain will assuredly be more certain. M. Dejean's magazines appear, therefore, to be a very important acquisition to agriculture.—*Ann. de Chim.* xxvi. 109.

9. *Adulteration of Tea.*—Mr. Sowerby has remarked a curious instance of Chinese adulteration in black tea, consisting in the addition of sandy matter to it, containing minute crystals of magnetic iron. These were sometimes so abundant, as to enable a magnet to lift parts of the leaves. The sand was often observed deposited in tea-cups and tea-pots, and on macerating some closely-twisted portions of tea, considerable quantities were separated, that had been introduced when the leaves were fresh.—*Phil. Mag.* lxiv. 151.

10. *Peculiar Fracture of Quartz.*—Dr. Brewster lately had occasion to examine a fractured specimen of quartz, in which the two new surfaces were of such a nature as to be incapable of re-

flecting light, and, therefore, appeared quite black. At first, it was supposed that a thin film of opaque and finely-divided matter had insinuated itself into a fissure of the crystal; but this opinion was soon overturned, and Dr. Brewster concluded that the effect was due to the surfaces being composed of short slender filaments of quartz, whose diameter was so exceeding small, that they were incapable of reflecting a single ray of the strongest light. The surfaces were perfectly transparent to transmitted light; no detergent substances had any effect on them, nor had hot acids; but when immersed in oil of anise seeds, a substance, which approaches to quartz in its refractive power, the blackness disappeared, and the piece of quartz behaved like any other piece of quartz. Upon removing the oil, the original state was restored, and the filamentous or velvety nature of the surface was rendered evident to the eye, by the slight change of tint produced by pressing the filaments to one side. Dr. Brewster concludes that the thickness of the filaments cannot exceed one-third of the one-millionth part of an inch, or one-fourth of the thinnest part of a soap-bubble.—*Edin. Jour. Science*, i. 108.

11. *Instrument for Examinations under Water.*—An optical instrument for seeing through water, and exploring the bottom of rivers, has been constructed by Mr. Leslie, of Lausenburgh, U. S. It consists of a conical tube of variable length, about one inch broad at the top, and ten inches at the bottom. It is glazed at both ends, and when the broad end is immersed to some depth in water, and the eye applied to the narrow extremity, there is no interruption to, or deflection of the rays of light coming from objects in the water to the eye, and if the water be clear, things in it may be seen with great facility. For use in the night, or in other circumstances, it is fitted with lamps, suspended near the bottom, in a shorter outer cylinder sliding on over the tube, and secured at its lower extremity; the mouth of this cylinder is glazed, so that the light of lamps, placed in it, is thrown into the water, and illuminates objects in it. Two tubes go to this close cylinder, one entering at the bottom, the other at the top; the one carries fresh air down, the other conveys the smoke and foul air upwards. The instrument is very useful in the speedy recovery of drowned bodies, or of lost property; in examining the beds of rivers, or other situations under water, to facilitate excavation, and on many other occasions.

12. *Preservation of Copper-plates.*—Dr. Mac Culloch has pointed out the great injury done to fine engravings on copper when they are laid aside, from oxidation. In large and expensive works, only the impressions immediately required are printed, and the plates are laid aside; after some time, they are re-worked, when it is necessary first to remove the film of oxide which has formed;

and the repetition of this operation produces great injury, in addition to that done by inking. To prevent this, Dr. M. proposes to varnish the plate when laid aside, either with common lac varnish, which may be removed, when requisite, by spirit of wine, or with caoutchouc varnish.—*Edin. Jour. Scien.* i. 76.

13. *Impermeability of Glass to Water.*—It has sometimes, though not often, we believe, been suggested, that glass and siliceous minerals are permeable to water. The Rev. Mr. Campbell, in a voyage to South Africa, sent two globular bottles, hermetically sealed, to a depth of 1200 feet in the sea, by two leads, one of 22lb., and the other of 28lb. When the rope was brought up by the exertion of ten men for a quarter of an hour, both vessels were found empty.

14. *On obtaining the rate of Chronometers on Ship-board.*

To the Editor *of the Quarterly Journal.*

Sir,

In Number XVIII. of the Astronomical and Nautical Collections, you have inserted an excellent proposal of Mr. Fallows, for regulating the chronometers of ships by the extinction of a light at the place of observation on shore.

A similar, and (as more extensively useful), perhaps, a better plan of effecting that purpose, was laid before the Admiralty fourteen years ago. The suggestion, however, was not adopted; but, if it were to meet with your support, and that the Board of Longitude were to recommend it to the present Admiralty, there is little doubt that it would be carried into execution, and still less that it would be attended with manifest advantage to His Majesty's service, as well as to all those India or other merchant ships who carry chronometers.

It is well known that the rate which a chronometer acquires when on-board of a ship *always* differs from that which it had obtained while on-shore. Hence the propriety of ascertaining the rate after it is placed in the situation it is finally to occupy; added to which, the obvious inconvenience of removal in bad weather, the risk of boats, the frequent carelessness of those employed, and many other circumstances concur in proving that a chronometer should not be disturbed if it is possible to fix its rate *in situ*.

With these views it was proposed, that at the Observatory, in Portsmouth Dock-yard, a flag-staff should be erected; that every day at a few minutes before some certain hour, a light opaque ball (such as is commonly used for distant signals at sea, and which would be visible to all the ships at Spithead,) should be hoisted; and that, at the precise moment agreed upon, the ball should be hauled down. Two balls, one under the other, and in close contact, would be still better, as their separation, by

hauling down the lower ball and leaving the upper one, could be observed with the greatest precision by any officer with a telescope. The two balls might be hoisted separately; the first ten minutes before the time, as a preparatory signal; and the second after an interval of six or seven minutes.

The best hour would be one p. m. as the crews are then generally at dinner, and as the astronomer would have had time to reduce his observations of the sun's transit, or to calculate the rate of his clock if no observation should have been obtained.

Yours, &c.

B.

Chemical Science.

1. *On the Electrical Effects observed during Chemical Action.* By M. Becquerel.—In his last memoir * M. Becquerel had pointed out many sources of electricity, as the contact of the vessels and liquids, which had exerted an influence during his earlier researches into the electrical effects produced by chemical affinity. In the one, of which the following is a brief account, the precautions which were adopted to obviate those disturbing influences are described: most of the former results are confirmed, and new ones added.

With regard to the electrical phenomena produced when acids and alkalies combine: Two equal porcelain capsules were taken; into one was put an alkaline solution, into the other an acid. The two fluids were connected by a plate of platina, and the platina extremities of the galvanometer wire were inserted one into each capsule. In this state, things being equal on both sides, there was no electrical action, but a wick of amianthus being laid on the intermediate platina so as to connect the acid and the alkali and bring them together, the magnetic needle was immediately affected so as to indicate that the positive electricity left the acid, and the negative electricity the alkaline solution, affording a full confirmation of the preceding results.

With respect to what takes place when an acid acts *chemically* on a metal, independent of the electro-motive force due to mere contact of the acid. A plate of gold is to be fixed in the platina forceps, terminating one end of the galvanometer wire, but preserved from actual contact by the intervention of some filtering paper. The whole of the gold, with the forceps also, are to be immersed in nitric acid contained in a platina capsule; and the other platina extremity of the wire is also to be introduced. In that state there are no electric effects, but the addition of a single drop of muriatic acid causes action on the gold; the needle deviates, and, by its direction, shews that the acid, as before, has taken the positive electricity, and the gold the negative.

* See our last Number, p. 374.

A plate of copper, or zinc, in place of the gold, yields similar results without the aid of the muriatic acid, and although sometimes the current changes its direction without any apparent reason, yet, generally, when an acid acts on an alkali or a metal, the acid takes the positive electricity, and the alkali or metal, the negative.

M. Becquerel remarks, that there are so many different chemical phenomena occurring when an acid acts on a metal, all of which have their respective power of exciting electricity, that it is no wonder anomalies sometimes occur; and he found he was able to remove some of these, even by the comparatively coarse precaution, of shielding the platina part of the galvanometer wire from particles which the chemical action might throw on to it; and by allowing time for the cessation of capillary action, and the removal of substances acted upon by the acid, from the surface of the plates or from the paper.

The question then occurred whether the heat produced by the chemical action, was, or was not, the cause of the electrical current. To ascertain this with regard to the action of an acid on copper, instead of using a plate of the metal, it was made into a small cylinder which was filled either with a coagulated fatty substance that would easily fuse, or with ice. It was considered that any free heat produced by chemical action would be employed in melting the enclosed substance, and therefore removed as fast as produced, but the effect was the same as before. Again, one end of the galvanometer wire was terminated by a platina vessel containing an alkaline solution, the other platina extremity, introduced at the same temperature, produced no electrical current; but when previously heated and then introduced, a current was produced; the positive electricity being produced by the heated side, and the negative electricity by the other. But in the experiment with copper in nitric acid, the current was in the opposite direction, and therefore could not have been due to any heat produced by chemical action.

The preceding electrical effects relate to currents, and M. Becquerel states, he was unable, even by the aid of his very sensible electrometer *, to detect electricity of any tension due to the action of nitric acid on copper, or of dilute sulphuric acid on zinc. The experiments, however, with the galvanometer have proved that when acids and alkalies combine, the acids take the positive electricity, and the alkalies the negative; whilst, by the electroscope, it was shewn that on contact only, without chemical action, the acids take the negative electricity and the bases the positive; a very remarkable distinction between the electrical effects due to chemical action, and those due to contact.

* *Quarterly Journal,* xvii. 374.

From what precedes, the solution of the following interesting question may be deduced. Two soluble substances being taken, sufficient conductors of electricity to exert on each other electromotive actions, to ascertain whether when the solutions are put together they form a mere mixture or a combination. In the first case the solid substances by contact would take the same electricity as their respective solutions would do when connected by amianthus; but the opposite states would be induced if there were chemical action. As examples of mere mixture, citric acid and muriate of ammonia, and citric acid and chloride of sodium may be quoted: the solid substances act similarly to the solutions, and thus offer further proofs of the difference existing between chemical combination and mechanical contact.

This difference between the electrical effects of contact and those of chemical action, indicate that there should be an intermediate state in which there is no development of electricity. In another memoir the means will be given of determining, as accurately as possible, this passage of one electric state to another in two substances, which, at first in contact without chemical action, end by combining together.

2. *On the Distribution of Electricity in the Voltaic Pile.* By M. Becquerel.—When a plate of zinc is immersed into diluted sulphuric acid, or any alkaline solution contained in a copper vessel, without contact of the metals, the vessel becomes positive and the zinc negative*. This result shews that the important fact, discovered by Volta, namely, that when a pile is formed entirely of metal the tension of the two extreme metals is the same as if they were in contact, is not applicable to the case where an acid or alkaline liquid is interposed between the two metals; for according to it, the zinc should be positive and the copper negative, whilst really the contrary is the case.

Represent the electric states of copper and zinc, when the two metals are separated by an acid solution by $+\delta$ and $-\delta$, and the quantities of electricity, which they take by contact, by $-\frac{1}{2}$ $+\frac{1}{2}$; put a disc of copper on the zinc: this, besides its electricity, $-\frac{1}{2}$ for instance, which it will take from the zinc, will divide its electricity $-\delta$, which it previously possessed; and, further, the liquid as a conducting body, will transmit to the first disc of copper, the electricity $+\frac{1}{2}$ of the zinc, so that the electricities will be—

* *Quarterly Journal*, xvii. 375.

Lower Copper	Liquid	Zinc	Upper Copper
$+\frac{1}{3}+\delta$	,,	$+\frac{1}{3}-\frac{\delta}{2}$	$-\frac{2}{3}-\frac{\delta}{2}$

on adding a stratum of liquid and a zinc plate, it will be as follows:

Lower Copper	Liquid	Zinc	Copper	Liquid	Zinc
$+\frac{1}{2}+\delta$	,,	$+\frac{1}{2}$	$-\frac{1}{2}$	,,	$-\frac{1}{2}-\delta$

and so on successively. In this mode of distribution the rule adopted by Volta has been followed, and though the tensions could not be measured, the probabilities are that it is correct. It is therefore almost certain that the electro-motive action of liquid conductors on metals, tends to augment the electric tension of the different elements of the pile.

As to the influence of the chemical action on the charge of the pile, or the rapidity of the current which takes place when the extremities are communicated, sufficient data are not as yet obtained to resolve the question.—*Ann. de Chim.* xxvi. 186.

3. *Supposed Electro-Magnetic Light.*—At p. 162 of our last vol. was quoted an experiment of M. Leopold de Nobili, on what he considered as electro-magnetic light. M. Antinori has repeated the experiment, and proved that the light was merely that occasioned by the passage of electricity from one part of the wire to another, by parts not well insulated. A spiral, made as directed, gave, not a brush of light from the centre only, but sparks here and there. Wrapping it well in silk and varnishing it, even these sparks disappeared; but, on removing a portion of the varnish from different parts of the wire, sparks again occurred at all those places, whenever the discharge was sent through it.—*Bib. Univ.* xxv. 281.

4. *On the Direction of the Axes of double Refraction in Crystals.*—It is known that the *optical axes* of crystals improperly called *crystals with two axes*, do not coincide with the axes of crystallization; but, until now, it has been regarded as a general rule that the lines which divide the angle, comprised between these optical axes into two equal parts, should be equally inclined on the corresponding faces of the crystal. M. Mitscherlich has ascertained that these lines, symmetrical with respect to the double refraction, are not so relative to the faces of the crystal; and that in some salts, as sulphate of magnesia, they incline more on one side than the other, when no want of symmetry in the crystalline forms could previously have raised a suspicion of such deviation (A. F.).—*Ann. de Chim.* xxvi. 223.

5. *On the Contractions produced by Heat in Crystals.*—M. Mitscherlich observed * that the mutual inclination of the planes of Iceland spar, varied sensibly by the effect of heat; and that between 32° and 212° F. the change of the diedral angles at the extremityof the axis of the rhomboid was $8\frac{1}{2}'$. Hence it results, that supposing no dilatation of the crystal perpendicularly to the axis, its cubical dilatation would surpass that of glass by nearly half as much again: but whilst measuring the cubical dilatation of Iceland spar with M. Dulong, M. Mitscherlich found that it was inferior to that of glass, and this leads to the singular consequence that whilst the heat dilates the crystal parallel to its axis, it causes it to contract in a direction perpendicular to it. M. Mitscherlich has assured himself of this fact, by measuring with a spherometer, the thickness of a plate of Iceland spar, cut parallel to its axis, at different temperatures.

It is very probable that sulphate of lime will present an analogous effect, but in the inverse direction, *i. e.*, that an elevation of temperature will produce a sensible contraction in the direction of its axis. (A. F.)—*Ann. de Chim.* xxvi. 222.

6. *Cyanuret of Iodine.*—Proceedings of the Society of Pharmacy at Paris, April 15. M. Serullas read a memoir on a new compound of nitrogen, carbon, and iodine, which he named cyanuret of iodine. This new product is obtained by heating an intimate mixture of two parts of cyanuret of mercury and one part of iodine in a small dry retort. When the temperature is sufficiently elevated, a white vapour rises, which condenses in the form of light flocculi or small brilliant plates, which are the cyanuret of iodine; there is produced, at the same time, protiodide of mercury, which remains in the retort. The cyanuret may be purified by a second sublimation. This substance has a strong poignant odour, exciting tears; its taste is very caustic, it does not alter litmus or turmeric paper. Thrown on hot charcoal it evolves violet vapours. It is soluble in water and alcohol. M. Serullas regards it according to his experiments, as a compound of 828 of iodine, and 172 of cyanogen.—*Jour. de Phar.* x. 256.

See Sir Humphry Davy on this substance. *Quarterly Journal,* I. p. 289.

7. *Selenium in the Volcanic Rocks of Lipari.*—Professor Stromeyer has lately discovered selenium under two different forms, one of which is altogether new. On diluting some fuming sulphuric acid, such as is made at Nordhausen from the sulphate of iron, he observed that a solid matter separated, and which, on examination, proved to be selenium One pound of the acid gave, on dilution, about a grain of selenium. This substance has

* See *Quarterly Journal,* xvii. 157.

already been detected in some of the Bohemian sulphuric acid, and it is supposed that the acid in question had been prepared in Bohemia. The second source of selenium is in the volcanic productions of the Lipari Isles, among which, Professor Stromeyer has lately discovered a native sulphuret of selenium.—*Edin. Phil. Jour.* xi. 216.

8. *On Titanium, by M. Peschier.*—M. Peschier, of Geneva, has lately been engaged in examining the various combinations of titanium. Many of his observations are analogous to those of M. Rose *, which we have not room, therefore, to refer to; others are new, and highly interesting.

Having observed the acid nature of oxide of titanium, M. Peschier boiled some ounces of finely-powdered rutilite in distilled water, then concentrated and filtered the liquid, which had the following properties: it was yellow, had a particular metallic taste, strongly reddened litmus paper, and destroyed its colour; it did not crystallize, but on evaporation gave a pulverulent substance, which was nearly all soluble in alcohol; it slowly precipitated salts of iron, copper, mercury, and lead, and, after some hours, nitrate of silver. Combined with potash, it gave a salt crystallizing in cubes; with soda, a rhomboidal salt slightly deliquescent, both soluble in alcohol; if the alkalies were in excess, the salt, with potash, was permanent in the air, that with soda, deliquescent.

Convinced of the acid nature of the oxide of titanium, M. Peschier endeavoured to acidify it to the highest degree. A mixture of nitrate of titanium and carbonate of potash, or of nitrates of titanium and potash, were submitted to a high temperature, and the residue diffused through water. A combination of the new acid with potash dissolved, and could be thus separated; and this being decomposed by sulphuric acid, the liquor evaporated, the substance dissolved in alcohol, (which takes the acid,) and the solution evaporated, gave the acid in acicular crystals. This acid has no sensible action on metallic or earthy salts; it has a disagreeable metallic taste; when subjected to the voltaic current, it gives out an odour of phosphorus, and deposits a black substance at the negative pole; combined with subcarbonates of potash and soda, it gives acicular prisms insoluble in alcohol, unless excess of the acid be present. The salts affect a rhomboidal prismatic form. M. Peschier proposes to call the liquid obtained from rutilite, titaneous acid, and the one just described, titanic acid.

M. Peschier endeavoured to reduce the dry oxide of titanium by heating it with excess of potassum; there was always heat, light, and the evolution of hydrogen gas, perhaps from the heated oxide; and then by washing, a black powder was obtained, which retained water unless heated in hydrogen: heated in the air or in oxygen,

* See *Quarterly Journal,* xvi. 381.

it became yellow, and white on cooling, but did not absorb much oxygen, only from 3 to 5 per cent. Heated very powerfully with oil, no change was produced. M. Peschier thinks that, perhaps, this powder is the radical of titanium, and may be analogous to borax. It gave the odour of phosphorus when moistened with muriatic acid. He concludes, also, from the examination of a small specimen, that the crystals of titanium, described by Dr. Wollaston, are a titanite of iron, analogous to the mamillated substance obtained by Laugier. There are, probably, not many persons who will join in this opinion, without some further and powerful reasons.

M. Peschier states that he has never been able to ascertain any action of the ferro-prussiate of potash on salts of titanium, and that it affords a certain means of separating iron from them: also that after the iron is separated, the infusion of galls is the only re-agent which will completely separate the titanium. For this purpose, care must be taken to evaporate the liquids submitted to its action, to dryness, to heat the produce to bright redness, to wash with water, and separate the insoluble portion, to destroy the carbonaceous part; wash again, and heat to redness again, and so on, two or three times.—*Bib. Univ.* xxvi. 43.

9. *Turrell's Menstruum for etching Steel Plates.*—Take four parts, by measure, of the strongest pyrolygneous acid, chemically called acetic acid, and one part of alcohol, or highly-rectified spirits of wine; mix these together, and agitate them gently for about half a minute; then add one part of pure nitric acid; and when the whole are thoroughly mixed, it is fit to be poured upon the steel plate.

When the mixture is compounded in this proportion, very light tints will be sufficiently corroded in about one minute, or one minute and a half; and a considerable degree of colour will be produced in about a quarter of an hour; but the effect may be produced much quicker, by the addition of more nitric acid, or it may be made to proceed slower, by omitting any convenient portion thereof.

When the mixture is poured off the plate, it should be instantly washed with a compound made by adding one part of alcohol to four of water, and the stopping varnish laid upon any part that is sufficiently corroded, should be thoroughly dry before the biting is repeated. Care should be taken to keep the mixture out of reach of the sun or any artificial heat, because its valuable properties, for this purpose, would thereby be changed. It will be necessary, also, to observe that no more of the ingredients should be mixed than are wanted for present use, as the mixture will be greatly changed if kept many hours.

The stopping varnish that answers the purpose best, is made by dissolving the best Egyptian asphaltum in the essential oil of turpentine, which dries sufficiently quick for all desirable purposes,

and perfectly secures the part covered with it, from the action of the menstruum.—*Tech. Rep.* vi. 134.

10. *Active principle of the Upas Poison.*—M.M. Pelletier and Caventou, after various trials to obtain the active principle of the *Upas tieuté*, and suspicious of its nature, adopted the following. An aqueous solution was prepared, which, when filtered, was treated with pure calcined magnesia; the reddish-yellow precipitate obtained, when washed and dried, was boiled in alcohol two or three times, and the solutions evaporated, gave an orange-coloured crystalline substance. This substance was bitter, only slightly soluble in water, very soluble in acids, and had all the properties of strychnia, except that of producing a green colour with nitric acid instead of a red one; but this effect was occasioned by the presence of a brown-coloured substance, for when a solution of the whole was made in weak sulphuric acid, passed through animal charcoal, precipitated by magnesia, and then dissolved in alcohol, and crystallized by slow evaporation, it lost the property of becoming green by nitric acid, and was perfectly pure.

In this state, it consisted of crystalline prismatic needles, nearly insoluble in water, very bitter, restoring the blue of reddened litmus paper, saturating acids, and with them forming solutions, in which ammonia, tincture of galls, and the alkaline gallates and oxalates, produced precipitates, soluble in alcohol; and in all things, except that of reddening by nitric acid, exactly resembling strychnia. The red colour, by nitric acid, belongs, therefore, to some other substance than strychnia, and on evaporating the water with which the magnesian precipitate was washed, a yellow substance, having this property, was obtained; and which redissolved, filtered through animal charcoal, and re-evaporated, gave a tolerably pure solution of the substance. This substance is uncrystallizable, fixed, soluble in water and alcohol, and not precipitable by acetate of lead; it exists only in small quantities in the upas.

In consequence of the purity of the strychnia obtained from the upas, specimens were examined from other sources, and it was ascertained that though most of them reddened by nitric acid, yet they varied in the extent of this property, and one very pure specimen scarcely exhibited the effect at all; hence, it may be concluded that the red colour is always due to a portion of impurity accompanying the strychnia. and does not belong to the alkali.

The strychnia, from the upas, produced all the effects on the animal economy that are produced by strychnia otherwise obtained.

The brown substance which produces a green colour with nitric acid, was found to be the same as that existing in the false angustura bark; when pure, it is without taste, but slightly soluble in water, darkened in colour by alkalies, and rendered a little more soluble. It dissolves in alcohol, and by evaporation, forms micaceous crystalline plates; it is very slightly soluble in ether or vola-

tile oils; with concentrated nitric acid, it yields a very intense green colour, disappearing by dilution, re-appearing by concentration; alkalies and all oxygenating bodies make it disappear entirely. Sulphuric acid also produces a green colour with this substance; muriatic acid has no action. It has no action on the animal economy.

Upas anthiar.—Boiled in distilled water, an elastic substance separated upon the surface, which was called elastic resin; an insoluble substance remained diffused through the liquor, which appeared intermediate between gum and starch; and a bitter solution was obtained, which being evaporated to the consistence of syrup, was treated with weak alcohol, which precipitated the gum, and held the bitter substance in solution. This solution evaporated, gave a crystalline granular substance, very bitter, very soluble in alcohol and water, and reddening tincture of litmus. It was of a brownish colour, but became paler by passing through animal charcoal. Suspecting that it was a vegeto-alkaline salt, it was treated with ammonia, but no precipitate obtained. Magnesia threw down nothing, but when the liquid was filtered off, it was no longer acid but alkaline, and with tincture of galls and alkaline gallates gave *precipitates entirely soluble in alcohol*, a character peculiar to the vegeto-alkalies. The small quantity of the upas prevented any further chemical examination of this substance.

The upas tieuté was in the form of a reddish-brown extract, translucid, excessively bitter, but without any acrid or aromatic flavour, and partly soluble in water, partly insoluble.

The upas anthiar was a slightly reddish-brown substance, having a waxy consistence and appearance; its taste was excessively bitter and somewhat acrid, and it caused a degree of numbness of the tongue and interior of the mouth.—*Ann. de Chim.* xxvi. 44.

11. *On the supposed Alkali of the Daphné*, by M. Vauquelin.—In 1808, whilst analyzing the *thymetea alpina and gnidium*, M. Vauquelin observed an alkaline matter, which he described as follows—“Taste acrid and continued, very volatile, and acting on vegetable colours like alkalies.” At that time, however, as the vegeto-alkaline bodies were unknown, he was too cautious to call this an alkaline substance: and has lately again returned to the subject.

The substance may be obtained by digesting a pound of dried Mezereon bark in a pint of water, for some hours, at temperatures from 140° to 160° Fah. Express the liquor, mix it with a little chalk, potash, or magnesia, and distil, as far as can be done without burning the residium; a colourless liquor is obtained, very acrid, of an irritating odour, and rendering reddened litmus paper blue. If the solution be required of greater strength, the liquor obtained by expression is to be slightly acidified by sulphuric acid, reduced by evaporation to a fourth or even an eighth of its original

volume, magnesia is to be added to it, and it is then to be distilled to dryness in a water-bath, condensing in cold vessels.

The odour of these solutions proves the volatility of the substance, and indeed if a piece of reddened litmus paper be hung over some of it in a flask, the blue colour is soon restored. The solutions saturate acids; and with sulphuric and nitric acids yield white and brilliant acicular crystals. When, however, a large quantity of this water was neutralized by muriatic acid, and evaporated, a salt was obtained which evidently contained muriate of ammonia. M. Vauquelin therefore thinks it possible that this ammonia may be the only cause of the alkalinity of the solution; and that the acrid principle has no alkaline property.—*Jour. de Phar.* x. 333.

12. *On Digitaline*, by M. Royer.—The active principle of Digitalis was obtained by digesting a pound of the plant of commerce in ether, first cold, and then heated under pressure; the solution was filtered and evaporated, the residuum dissolved in water and filtered, the solution treated with hydrated oxide of lead, the whole evaporated and digested in ether, which dissolved out the active principle; on evaporation it appeared as a brown pasty substance, slowly restoring the blue colour of reddened litmus paper, very bitter and very deliquescent. It is very difficult to obtain it crystallized, but a drop of its solution in alcohol, evaporated on glass, over a lamp, when examined by a microscope, gave abundance of minute crystals.

That conviction might be obtained of the active nature of this substance, a grain was dissolved in about 180 grains of water, and injected into the abdomen of a rabbit; in a few minutes respiration diminished, the circulation diminished, and the animal speedily died without agitation or pain, which is the more remarkable as the rabbit is convulsed with great facility. Half a grain in 120 grains of water, ejected into the veins of a cat, caused a similar death in about 15 minutes. One grain and a half in half an ounce of water, introduced into the jugular vein of a dog, caused death in five minutes. In all these cases the arterial blood presented a decidedly venomous tint, and coagulated with difficulty.—*Bib. Univ.* xxvi. 102.

13. *Analysis of the Male Fern Root.*—According to M. Morin this root, which is employed with success as an anthelmintic, owes that property to a fatty substance, capable of being saponified, of a nauseous odour quite like that of the root, of a very disagreeable taste, heavier than water, distilling with water, and when burnt giving a dense aromatic smoke. The root contains besides, gallic and acetic acids, uncrystallizable sugar, tannin, starch, a gelatinous matter insoluble in water and alcohol, lignine, and various salts which are found in its ashes. M. Morin considers the fatty part as formed of a fixed and a volatile oil; but he has not given proofs

sufficient, and it is desirable that he should make the characteristic principle of this root better known.—*Ann. de Chim.* xxvi. 219.

14. *Oil of the Dahlia.*—At the same that M. Payen had occasion to signalize the existence of a peculiar vegetable principle in the Dahlia *, he noticed, in connexion with it, a peculiar vegetable oil. Further experiments with the oil have shown it to contain two distinct substances, the one a crystalline body having many of the characters of benzoic acid, and the other a fluid uncrystallizable at low temperatures. Both are soluble in alcohol and acetic acid, but almost insoluble in water; they may be separated by cooling the mixture to the crystallizing point, decantation, and pressure of the crystals.—*Jour. de Phar.* x. 239.

15. *Crystallization of Bitumen.*—The notes of proceedings of the Royal Academy of Medicine, at Paris, mention indications of the crystallization of bitumen in compressed polyhedrons, announced by M. Sido; and this gave occasion to the remark by some members, of the appearance of small granular opaque crystals in rectified petroleum, when preserved for a length of time.—*Jour. de Phar.* x. 307.

16. *Effect of light on colour of Sodalite.*—Mr. Allan observed a very interesting phenomenon, in relation to the action of light upon the colour of the Sodalite of Greenland. When the massive variety is broken up, many portions of it have the most brilliant pink colour; but after a day's exposure to the action of light this colour almost entirely vanishes. Having broken a specimen into two, Mr. Allan kept one of them in the dark, and exposed the other to light; the specimen kept in the dark retained its pink colour unimpaired, while the other lost it almost entirely.—*Edin. Jour. Sci.* x. 181.

17. *Cleansing of Gold Trinkets.*—Dr. Mac Culloch proposes to cleanse gold trinkets, such as chains, *&c.*, by boiling them in ammonia instead of acid. Such trinkets are generally made of an alloy containing much copper, and therefore require what the jewellers call colouring, that is the removal of copper, so as to leave a surface of pure gold. After some time the surface wears off and the trinket requires cleaning, or a repetition of the former process: this is generally done by an acid, but as gold is dissolved in that way and consequently fine work, after two or three cleanings, very much injured, Dr. Mac Culloch recommends the use of ammonia, which does not involve this injury, and which can be applied by any person as well as the jeweller. The effect depends upon the power

* Quarterly Journal, xvi. p. 87.

which solution of ammonia has of oxidizing and dissolving metallic copper.—*Edin. Jour. of Sci.* i. 75.

18. *Action of Nitric Acid and Charcoal.*—Professor Silliman formerly pointed out the production of hydrocyanic acid by the action of nitric acid and charcoal. M. Frisiani has also observed the same effect produced, in a very striking manner, during the action of nitric acid on the residuum obtained by calcining sulphate of baryta with vegetable charcoal, and removing every thing soluble in water by repeated washings. A strong odour of hydrocyanic acid was produced, and when the action was made to take place in a Woulfes bottle, the tube of which passed into a solution of potash, the liquor collected, when rendered slightly acid, and precipitated by persulphate of iron, gave a precipitate, which washed with muriatic acid became Prussian blue. Nitrates of the earths, or alkalies, boiled with vegetable charcoal, gave no result of this kind. When the nitrates and charcoal were mixed in the dry way and heated, the action was, of course, violent, but no important results were obtained.—*Gio. de Fis.* vii. 240.

19. *Camelion Mineral.*—Dr. Marabelli, of Pavia, finds that in the preparation of camelion mineral, by potash and oxide of manganese, the protoxide, or rather the carbonate obtained by precipitating any of the salts of manganese, by carbonate of potash, is infinitely preferable to the native peroxide usually employed, however finely the latter may be divided. Dr. M. is of opinion that the preparation contains a protoxide of manganese, and that hence it is that protoxide is preferable to peroxide: but this opinion will hardly hold against the experiments of Chevillot, Edwards, and others—.*Gio. de Fisica,* vii. 22.

20. *Concentration of Alcohol by Bladders.*—The effect produced by inclosing diluted alcohol in a bladder is well known, namely, the concentration of the alkali. This fact was first observed by Soemmering, and it has even been proposed to improve wines by an application of it, as, for instance, by closing the mouths of bottles with it instead of corks. It is now stated that M. Soemmering has succeeded by the same means in separating the water from alcohol entirely, so as to have the latter quite pure or absolute. The process is to put alcohol of 75° of the areometer of Soemmering into an ox's bladder, or else into a calf's bladder coated with isinglass, which is to be hung over a sand bath; in a few days the alcohol will lose one quarter of its volume, and be found quite free from water (absolute alcohol.)—*Gio de Fisica,* vii. 239.

21. *Pure Hydrogen—Properties of Amalgam of Zinc.*—M. Bischof has remarked that an amalgam of zinc treated with a solution of potash furnishes hydrogen gas of a purity surpassing that obtained

by any other means. He also remarks, that in consequence of this circumstance, and thes mall quantity of zinc requisite to produce the effect, it may frequently happen that whilst analyzing gases over mercury, when solution of potash is used to absorb carbonic acid gas, errors may be introduced from the evolution of hydrogen. Another observation is, that mercury, through which hydrogen gas from zinc had passed, had dissolved zinc and obtained the power of absorbing oxygen from the air; and that with such rapidity as to suggest the notion that an amalgam of a small quantity of zinc might even serve some useful eudiometrical purposes.—*Gio. de Fisica*, vii. 238.

22. *Coating for Specula.*—An amalgam of two parts of mercury, one of bismuth, one of lead, and one of tin, is sometimes used to cover one surface of blown glass, or glass of any form, so as to make it a mirror. An inconvenience, connected with the use of this substance in experiments or otherwise, results from the constant fluidity of the metallic surface, so that it is easily displaced. M. F. Lancellotti having occasion to make experiments of this kind, was induced to search for some other alloy for the production of these reflecting surfaces. He found that a compound of three parts of lead and two of mercury, fused, and thrown with a certain degree of quickness and dexterity over the clean dry surface of the hot glass, formed a metallic coat which adhered firmly to the glass. It is requisite that the glass should be uniformly heated, and that it should also cool uniformly; and that after the amalgam is fused, its surface should be perfectly cleaned from any powder or oxide.—*Gio. de Fisica*, vii. 132.

23. *Castorina, a new animal substance*—The following substance is described by M. Bizio in the *Giornale de Fisica*, vii. 174. Some castor was boiled in six times its weight of alcohol, 0.85, the liquor filtered when hot and set aside for two or three days, gradually deposited a substance which had no regular form, was extremely light, and fell into powder under the fingers. Alkalies had no action on this substance, when their solutions were boiled on it, except to remove colouring matter and thus render it purer. It was but slightly soluble in cold alcohol, more, as has been seen, in hot alcohol: cold water scarcely dissolved any of it, hot water took up a small portion. The cold solution in alcohol, when spontaneously evaporated, gave the substance in small prismatic acicular crystals, some lines in length, diaphanous and white. It dissolves in ether very readily. When heated it fuses and appears to boil, vapours arise from it, which in the open air burn brilliantly; in close vessels it gave the usual products of a vegetable substance, nothing occurring to indicate its animal origin.

24. *Strength of Chloride of Lime, or Bleaching Powder.*—The fol-

lowing abridgment is from a paper of instructions how to ascertain the value of this important bleaching agent, drawn up by M. Gay-Lussac. The instructions are divided into two parts, the first relates to the principle upon which the trial of strength is founded; the second describes an instrument called a chlorometer, and the mode of using it.

It is known that chlorine has the power of destroying vegetable colours; and whether it be gaseous, dissolved in water, or united to an alkali, the same quantity of chlorine will destroy the same quantity of colouring matter. But as, when united to an alkali, it is fixed, has scarcely any odour, is more readily preserved, is more fit for carriage, and is much more concentrated; it is evident that this is the state which presents most advantages in its application.

The combinations with potash, soda, and lime, are easily formed; the two first have been long known in France under the name of *eau de javelle;* but in consequence of the re-action of the chlorine on the alkalies and the production of inert bleaching compounds, when concentrated, they can only be obtained in a very dilute state. The third has been called oxymuriate of lime, but should be called chloride of lime: it has not the inconveniences of the former, but may be obtained, as is usual, in the solid form.

As usually prepared, it is, according to M. Welter, a hydrated sub-chloride of lime, containing two proportions of lime, two of water, and one of chlorine: when put into water it is decomposed, half the lime precipitates, and the other half, combined with the whole of the chlorine, remains in solution as a neutral compound. The latter substance is very soluble, but may be obtained crystallized in small prisms. The solution exposed to the air absorbs carbonic acid, chalk precipitates, and the chlorine remains in solution; but excess of lime in the solution prevents this effect *.

The mode of measuring the chlorine to which preference has been given is that of M. Descroizilles, founded on the property which chlorine has of destroying the colour of indigo. One of indigo dissolved in nine of strong sulphuric acid and diluted with 990 of water forms the usual test liquor. In similar circumstances the chloride of lime discolours a quantity of test liquor proportionate to its own; but by varying the circumstances, the effect may be varied also: for by pouring the chloride slowly into the test-liquor, much more of the latter is discoloured than if it be poured slowly into the chloride. The most constant effects are obtained by rapidly pouring the one into the other, as to be afterwards described.

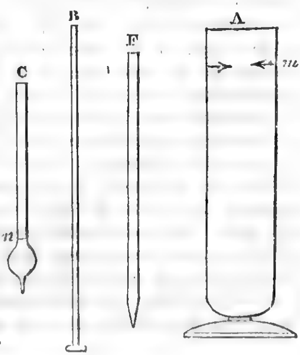
As indigo varies, it is requisite in the first place to fix a standard for it; and the unit of decolouring force has been taken, after the example of M. Welter, from dry chlorine at the pressure of 29.92 inches, and temperature of 32° Fah., the solution of indigo being made of such strength as to have ten volumes dis-

* See what Dr. Ure says on this subject, *Quarterly Journal.*

coloured by one volume of chlorine. Hence on dissolving ten grammes of chloride of lime in water, so as to form one litre of solution, the number of volumes of proof liquor discoloured by one volume of the solution will indicate the number of tenths of a litre of chlorine, which the ten grammes contained; consequently a kilogramme of chloride of lime which has, by such examination given 7°. 6 or 76-hundredths will contain seventy-six litres of chlorine. Each degree, therefore, is equal to ten litres per kilogramme of chloride, and each tenth to one litre. Supposing the sub-chloride of lime perfectly pure, it would contain 101.21 litres of chlorine per kilogramme. Generally the most accurate results are obtained with a weak solution of chlorine, one, for instance, which marks four or five degrees: if therefore it is found that a solution much surpasses 10° it is well to dilute it with an equal quantity of, or twice as much water, and then double or triple the number of degrees found by the instrument.

As oxide of manganese varies in quality, it requires to be examined. Pure peroxide is formed of manganese 3.5578 grammes and oxygen two grammes; it will produce 4.4265 gr., or 1.3963 litres of chlorine, at the temperature and pressure before-mentioned; so that 3.98 gr. will produce one litre of chlorine, and one kilogramme, 21.23 litres of chlorine. In the examination therefore 3.98 gr. of the oxide to be examined are to be treated at a moderate heat with muriatic acid in excess, and the chlorine received into a little less than one litre of milk of lime. Towards the end of the operation the mixture in the retort is to be boiled to expel all the chlorine from the vessel, the milk of lime is to be made up to a litre with water, and this chloride tested as before, will give the value or power of the oxide of manganese.

The chlorometer consists of a small balance; a weight of five grammes; a mortar to pulverize the chloride of lime, which is necessary to ensure exactness; a jar A. containing half a litre up to the circular line *m.*, terminated by two arrows; the surface of the water should be made to coincide with this line and not the upper edge; an agitator B. to mix the solution of the chloride, it is to be passed up and down, through the liquid. A small C. measure of two and a half cubic centimetres, intended to measure the solution of the chloride; it is to be immersed below *n* and filled by applying the mouth to the top; then placing the finger on the top it is easy, in the usual manner, to allow the escape of



its contents until the surface stands at *n*, when the finger is to be closed on the top, and the rest of the fluid within put into a large drinking-tumbler in which the mixture with the test-liquor is to be made. This glass should be placed on a sheet of white paper. A measure D, for the test-liquor, each great division, or degree, being equal to the capacity of the measure C. This measure is to be filled above the graduation with the test-liquor; and then the excess dropped out at the beak, which should be greased, or waxed, to make the drops more distinct. E is a measure graduated like the first but inversely, and intended to contain the quantity of test liquor, to be poured suddenly into the chloride. A tube F, contracted at its lower extremity, considerably facilitates the mensuration of the liquid; for by applying the finger at the top, small quantities can be readily added to, or subtracted from, that in the measure, until it coincides with the required degree.

The test-liquor is made by heating one part of finely-powdered indigo with nine of strong sulphuric acid at 212°, for six or eight hours, and then diluting it until ten volumes of it are decoloured by one volume of chlorine. A liquid containing its volume of chlorine, may be prepared with sufficient accuracy by treating 3.98 grammes of oxide of manganese, crystallized in fine needles, with muriatic acid, and receiving the chlorine in a milk of lime, afterwards to be brought to one litre by the addition of water, as was before mentioned; but if great exactness be required, the gas must be prepared, dried, measured, and its volume corrected for temperature and pressure, and then absorbed by a milk of lime.

It is highly important to preserve the test-liquid from light.

For the trial of the chloride; take various specimens from the mass of chloride to be examined, and mix them well; weigh out five grammes, which rub in the mortar with enough water to make a cream; then add a fresh portion of water, pour off the upper portion of the mixture into the jar A, taking care to lose none of it; then add more water to the residue of the chloride in the mortar, rub it again, and repeat this till the whole is mixed up and introduced into the jar; wash the last portions from the mortar with a little water, and make up the volume to half a litre, which stir well, so as to render it homogeneous. Fill the measure D up to 0° with the proof liquor, and pour into the tumbler such quantity of it as may be supposed somewhat inferior to that which a measure of the chloride will decolour, 5° for instance. Take a measure of the chloride with the instrument C, and by blowing, force it rapidly into the test-liquor, stirring at the same

time. If the colour entirely disappears, add instantly from the measure D, until the colour becomes slightly green; the quantity of test-liquor then deficient in the measure, will indicate the strength of the chloride, provided the second portion added was not more than $\frac{3}{10}$ of a degree. If it amounts to more, a second operation must be performed: the measure is again to be filled with test-liquor, and then as much poured from it into the tumbler as was found requisite by the last operation, and a hundredth or two over, and then proceed as before. When the quantity produces, at once, the proper tint, an expression is given by that quantity, of the strength of the chloride, correct to at least $\frac{1}{50}$ part.

The tube E is intended to make the trial by pouring the indigo suddenly into the chloride. The quantities are ascertained as before, and then the trial is repeated by measuring out the proper quantity of test-liquor into the tube E, and pouring it rapidly into a new measure of chlorine; test-liquor is then to be added, until the green tint is obtained just as before. The trials made in this way, are to be conducted exactly as in the former manner, but as the results are the same, it has nothing to render it preferable.—*Ann. de Chim.* xxvi. 162.

Gramme	15.44 grains.
Kiiogramme	2lb. 3oz. 5dr.
Litre	2.1133 pints.

III. Natural History, &c.

1. *Aurora Borealis in Iceland.*—Dr. Thienemann, who passed the winter of 1820-21 in Iceland, made numerous observations on the Aurora Borealis, of which the following are the general results:—1. The Aurora Borealis has its place in the lightest and highest clouds of our atmosphere. 2. It does not occur in the winter and at night-time only; but at all times, being visible, however, only in the absence of the sun's rays. 3. It has no determinate relation with the earth. 4. No sound occasioned by it has ever been heard. 5. The form in Iceland is generally that of an arc, extending from N.E. to W.S.W. 6. The motions are variable, but always occurring within the limits of the clouds containing the meteor.—*Revue Ency.* xxii. 734.

2. *Drosometer. Annual quantity of Dew.*—M. Flaugergues has been engaged at Viviers (Ardêche) in endeavouring to estimate the quantity of dew deposited at various times in the course of a year. The instrument contrived for this purpose was a circular tin plate 109 lines in diameter, with a border two lines in height; it was painted with oil-paint of a grey colour, and supported on a stick in the midst of a garden, about three feet six

inches above the earth. It was examined every morning at sunrise: if it contained dew, the liquid was carefully introduced into a phial of known weight, and weighed; the portion adhering to the moistened surface was estimated, from the results of many experiments, at 30 grains, and added to the weight of that in the bottle. If the drosometer, as the instrument was called, was merely moistened so as not to run with fluid, the quantity was estimated at 30 gr.; if it was less, an estimation was made, as nearly as could be done, by judging of the quantity. The weight once ascertained, it was compared with a table constructed from the weight of a known column of water, of equal diameter with the instrument, by which means M. Flaugergues thinks it is easy to ascertain the thickness of the coat of dew to the $\frac{1}{2000}$ of a line.

As an instance of the use of this instrument, the quantity of dew and rain which fell in 1823, and the number of days on which it fell, is given as follows:—

	DEW.		RAIN.	
	Lines.	Days.	Lines.	Days.
January	0.093	2	37.19	19
February	0.076	3	26.92	15
March	0.059	4	30.29	11
April	0.084	4	52.77	16
May	0.326	17	14.27	8
June	0.330	16	51.45	14
July	0.153	10	47.91	6
August	0.070	6	2.63	7
September	0.215	13	90.14	6
October	0.749	19	74.58	10
November	0 432	17	6.67	8
December	0.314	14	7.99	12
	2.901	125	442.81	132

The rain is to the dew as 152½ to 1. March was the month in which the least dew fell. October the month in which the most was deposited.

M. Flaugergues puts but little confidence in these experiments and observations as yet, but they seem to give some general ideas on the quantity of dew deposited. He is continuing the experiments with drosometers made of various substances; and many other precautions will be suggested by the knowledge of dew furnished to us by Dr. Wells.—*Bib. Univ.* xxv. 261.

3. *Rain-Gauge.*—M. Flaugergues has two rain-gauges, one placed on the top of an observatory, and the other in a court-yard beneath. During the year 1823, 36 inches 10.81 lines of rain fell into the first, and 39 inches 5.4 lines into the second. This excess in the lower rain-gauge has been constantly observed; and the observation of six years gives the ratio of the two quantities as 19

to 18 nearly. This effect is attributed to the direction in which the rain arrives at the two instruments; in the lower one from the shelter afforded by the buildings, it is supposed to fall in a direction approaching more to a vertical line than above, where the wind influences the drops until they enter the instrument; and in support of this opinion it is remarked that when snow falls, the difference is greater, the wind having greater power over it.

Though the fact appears to be certain, yet the cause will probably be considered as not clearly made out.—*Bib. Univ.* xxv. 265.

4. *Mountain Tallow.*—Specimens of this substance were lately found in a bog on the borders of Loch Fyne. This curious mineral was first observed by some peasants on the coast of Finland, in 1736; afterwards it was found in one of the Swedish lakes. M. Herman, physician of Strasburgh, observed a similar substance in the water of a fountain near that city, and Professor Jameson met with it in this country. It has the colour and feel of tallow, and is tasteless. The following notice in regard to it was sent us. It melts at 118°, and boils at 290°., when melted it is transparent and colourless, on cooling it becomes opaque and white, though not so much so as at first. It is insoluble in water, but soluble in alcohol, oil of turpentine, olive oil, and naphtha while these liquids are hot, but it is precipitated again when they cool. Its specific gravity in the natural state is 0.6078, but the tallow is full of air-bubbles, and after fusion, which disengages the air, the specific gravity is 0.983, which is rather higher than that of tallow. It does not combine with alkalies nor form soap. Thus it differs from every class of bodies known; from the fixed oils in not forming soap, from the volatile oils and bitumen in being tasteless and destitute of smell. Its volatility and combustibility are equal to that of any volatile oil or naphtha.—*Edin. Phil. Jour.* xi. 214.

5. *Aberthaw Limestone.*—This limestone, which is highly esteemed for the goodness of the lime which it yields, I have found to consist of

Carbonate of Lime	86.17
Alumina	7.10
Silica	3.40
Carbonaceous matter	1.67
Moisture	1.00
Oxide of Iron	0.66
	100.00

R.P.

Ann. Phil. N. S. viii. 72.

6. *Analysis of the Holy-Well water, near Cartmell, Lancashire.* By J. C. Woolnorth, Lieut. R.N.—This spring is situated at the

base of a bluff hill called Humphrey Head, the extreme point of a range of calcareous hills forming the eastern boundary of the Vale of Cartmell. The water is emitted through a small lead tube about an inch in diameter, surrounded and enclosed by rough masonry, and which delivers a gallon of water in about 1′ 47″. The specific gravity of the water is 1.006, and the relative proportions of its contents appear, from various experiments, to be as follows, in a wine pint of the water:—

Carbonic acid gas	One cubic inch.
Carbonate of magnesia	0.266
Sulphate of soda	3.872
———— lime	1.500
———— magnesia	3.000
Muriate of soda	19.782
——— magnesia	9.000
Peroxide of iron	1.750
Insoluble in muriatic acid, principally silica	3.000
	42.170 grains.

7. *Eruption of Sulphuretted Hydrogen.*—A singular phenomenon has occurred on the river Calfkiller, near the salt-works, about three miles from Sparta (Turna), in the United States of America. A column of fire, nearly forty feet high, rose from the waters in the middle of the river; it extended over a space of fifty verges, and illuminated objects at a considerable distance, the tints thrown over them were red, green, yellow, blue, *&c.* It seems to have been occasioned by a sudden burst of sulphuretted hydrogen which was inflamed by the approach of a lighted torch. The liberation of the gas is attributed by some to the operations of the workmen who were looking after salt, but the explanation seems doubtful.—*Revue Encyclopédique.*

8. *Ammonite containing Shells.*—M. L. A. D'Hombres-Firmas, describes certain ammonites, found between Vezenobres and le Gardon, about two leagues from Alais, on a hill about 130 metres high, of a calcareous rock, white externally, bluish internally. The ammonites occur whole and in fragments, many of the fragments of a large size; one, and only one, which was found by the author himself several years since, is remarkable for containing shells. It is fractured, but has been about 11.8 inches in diameter. In most things it resembles other ammonites: but about fifteen other shells, imbedded in its substance, appear at its surface, and, probably, there are others within; some present the edges, others, portions of convex surfaces, and others apertures; they are bivalves, and, probably, terebratula; they are nacreous, and from three-quarters of an inch to one inch in size.—*Bib. Univ.* xxvi. 61.

9. *Analysis of a Calculus.* By M. Laugier.—This calculus was removed after death from the bladder by a spoon, being too friable to be otherwise handled. When dry it was of a deeper brown colour than when moist. The calculus was analyzed by being pulverized and boiled in successive portions of water which removed uric acid, urate of ammonia and phosphate of ammonia. Muriatic acid was then applied, which took up nothing but oxalate of lime, and left merely animal matter. The results were

Soluble in water,	Uric acid	1.0
	Urate of ammonia . .	4.0
	Phosphate of ammonia	0.5
Insoluble in water,	Oxalate of lime . . .	1.5
	Animal matter . . .	2.0
	Loss and water . . .	1.0
		10.

Hence it may be remarked, 1st. That the animal matter was present in much larger quantity than usual. 2. That urate of ammonia is more soluble in hot water than is generally supposed. 3. That the phosphoric acid was combined with the ammonia and not with the lime, as might have been supposed if the calculus had been heated before the application of moist agents.

M. Laugier then remarks, that having heated a portion of the same calculus with a weak solution of caustic potash with the intention of separating the uric acid from the oxalate of lime, he found the latter to be entirely decomposed, and nothing but carbonate of lime left, the oxalic acid having entirely gone to the alkali. Repeating the experiment with artificial oxalate of lime, it was entirely decomposed by two portions of alkali; and, again, working on a very hard oxalate of lime calculus the same effect took place. Hence it follows, that a solution of potash is not a good means, especially when hot, of separating oxalate of lime from substances soluble in that alkali, which contains almost always carbonic acid, or can absorb it during the process.—*Jour. de Phar.* x. 258.

10. *New Method of destroying Calculi.*—The method proposed by Dr. Civiale of destroying calculi in the bladder, has been reported on to the Academy of Sciences by M. Percy. The following is the account given of it in the *Annales de Chimie*:—A straight silver sound is introduced through the urethra into the bladder; it contains a second also of silver and hollow, and terminated by three spring branches which lie close together when confined by the principal sound, but when pushed forward beyond it separate and form a sort of cage into which, after a little while, the stone is made to enter; the operator then closes the cage on it by drawing

the interior sound towards himself. The second sound contains a long steel rod terminated at the extremity between the branches of the cage by a small circular saw, a file, or other instrument, according to circumstances. When the stone is well fixed this rod is pushed against it, and by means of a wheel at its external extremity, and a spring bow is made to revolve in the manner of a drill: immediately the dull sound of the rubbing, or breaking down of the calculus is heard; and the operation for the time is generally finished by the ejection of the fragments, greater or smaller both in size and number, which, mixed with the urine, or with injected warm water, pass by the urethra, already distended by the large sound.

This process was practised before the Commissioners of the Academy, January 13, on a man named Gentil, thirty-two years of age. On the 3d of February, the third day of operation, the stone was entirely removed; there had been scarcely any pain, and the patient always went on foot to M. Civiale's house. A man of the name of Laurent, of Rheims, was the second patient treated; the stone was broken with equal success, and was found to have a white kidney-bean for its nucleus. The third and last example before the commissioners, was a man of the name of Peros, who had a stone as large as a pigeon's egg, its complete destruction was effected by the same means.—*Ann. de Chim.* xxvi. 96.

11. *Effects of Lightning on the Human Body.*—The following is an extract from an account by Dr. Tilesius, of Mulhauzen, given in *Schweigger's Journal.*

Two vehicles were passing along a narrow road embedded in a forest: in the first were two brothers of the name of Teele, one aged thirty-three years, the other twenty-nine; in the second was M. Teele the nephew, aged twenty years, and M. Decker. The lightning struck successively the first horse, the two brothers, M. Decker, and his companion; the last did not survive. The horse remained dead on the spot: the skin on the lower part of its belly was torn, the mouth open and the teeth black.

The lightning passed to the younger Teele by his umbrella, which, with his watch, was thrown twenty-four steps off; the vehicle had a hole made in it six inches in diameter. The body, carried to the nearest village, was put into a warm bath and rubbed; blood flowed from the nose, mouth, and ears, but no signs of life appeared. The mouth and nose were black; the skin and muscles of the arms and hands, both of which held the umbrella, were furrowed to the bone; the sleeves of his clothes were torn; the lesions of the skin were not like those produced in burns; the skin appeared as if it had been raised by rapid rubbing, and the clothes bore no trace of burning but seemed as if torn by a sharp point. M. Decker, who was in the same car, received at the same moment, a blow on the stomach so violent that he was thrown

out and remained insensible for half an hour. When examined, the place on which he felt the blow was found very red but unwounded; he very speedily recovered.

The two brothers were sitting side by side when struck; the lightning first reached the head of the elder brother, tore his velvet cap into several pieces, glanced over the temporal bone about an inch above the left ear, then behind that ear, and flaying the skin slightly, descended to the neck; it traversed the nape of the neck obliquely, and ascended to the right ear, the interior of which was as if scratched; it then went by the right shoulder, beneath the chin, over the right breast along the arm, and returning to the back, descended along the vertebral column to the sacrum. In this last part of its course, the skin was not torn, but only slightly raised, and much reddened; marks of the same kind were across the arms, and with the torn clothes, shewed the zig-zag path of the lightning as it had passed alternately from the right side of the younger brother to the left side of the elder. It continued its course on the former from the part where it had come in contact with some pieces of metal contained in his pocket, and at which place it had raised the skin of the muscles of the side, for a space as large as a hand; it then crossed the stomach to the left side, and passed over the internal surface of the thigh, knee, and calf of the leg. The width of the trace marked by the lightning, was generally about two inches; the wounds were most extensive and deep at the intersections of this trace; many of them were very painful, and suppurated abundantly; the skin had been closely rolled up on the right and left by the rapid passage of the lightning. The wounds did not bleed; and on healing, those phenomena only took place which accompanied the simple formation of skin. Nothing indicated a lesion of the organs due to fire or heat, but the effect was just such as would have been produced by the passage of a bullet over the surface.

The two brothers, on becoming sensible, felt excessively sick, and after drinking some tea, vomited several times, throwing out a little blood. No fever occurred. The eldest was quite deaf on the day of the accident, but recovered his hearing, in part, on the morrow. No paralysis occurred in the limbs struck by the lightning, and the wounds cicatrized in a few weeks.

The accident happened in May, 1821. Twelve months afterwards, the elder brother remained affected by deafness, which varied with the weather; he had a strong tendency to sleep, and sometimes slept twenty-four hours if not awakened. The younger, ultimately, had an inflammatory fever, and was subject to a periodical depression, of which he had previously felt nothing; and, generally, a much stronger impression had been made on the nervous system of both, than from the vigour of their constitution might have been expected.—*Bib. Univ.* xxv. 318.

12. *Exhalation of Water during Respiration.*—Dr. Paoli and Professor Regnioli have had an opportunity of ascertaining the disputed point, whether the water exhaled in the act of respiration came from the lungs, or was owing to the exhalation formed in the aërial and nasal passages, as has been asserted by M. Majendie. Theresa A—— had undergone the operation of tracheotomy, and it was observed that the air passing from the wound in the trachea through a canula, became visible by the condensation of the aqueous vapour, at 4° R. A glass was applied, four inches distant from this canula, and was covered with moisture.

M. Paoli enters into long discussions on the hypothesis usually advanced on this subject, and comes to the following conclusions: —1. That the aqueous vapour, which accompanies the act of breathing, is formed from the whole surface of the respiratory organs. 2. That it takes place from simple exhalation from the mucous membrane investing these organs. 3. That all the oxygen gas, consumed in respiration, is employed in the production of carbonic acid. 4. That the formation of this acid begins in the lungs, goes on in the arteries, and in the circulation, is brought to the lungs with the venous blood, and that by this means the animal heat, produced by the combination of oxygen with the carbon of the blood, is extended to the whole animal economy.—*Med. Journal.*

13. *Prize Questions proposed by the Royal Academy of Sciences.*—*Mathematics.*—A method of calculating the perturbations of the elliptical motions of comets, applied to the determination of the approaching return of the comet of 1759, and to the motion of that observed in 1805, 1819, and 1822. The prize, a gold medal of 3000 francs value, to be adjudged in June, 1826.

Natural Philosophy.—To determine by a series of chemical and physiological experiments, what are the successive phenomena that occur in the digestive organs during digestion. The prize, a gold medal of 3000 francs value, to be adjudged, June, 1825.

Mathematics.—1. To determine, by multiplied experiments, the density acquired by liquids, and especially mercury, water, alcohol, and ether, by pressure, equivalent to that of many atmospheres. 2. To measure the effects of the heat produced by those pressures. The prize, a gold medal, 3000 francs in value, to be adjudged, June, 1826.

M. Alhumbert's prize.—A gold medal of 300 francs value, to be adjudged in 1825. Subject. To compare, anatomically, the structure of a fish and that of a reptile, the two species to be at the choice of the candidates.

A second medal of 300 francs value, will be adjudged in 1826.—Subject. To describe, with precision, the changes to which the circulation of the blood in frogs is subject during their different metamorphoses.—*Ann. de Chim.* xxvi. 196.

14. *Geographical Prize.*—The Geographical Society of Paris has announced the following prizes. A medal of 3000 francs value, under certain conditions, as an encouragement for travels in Africa, to be adjudged in 1826.—A medal of 1200 francs value, on the subject, to ascertain the direction of the mountain-chains of Europe, their ramifications, and successive elevations throughout their whole extent, to be adjudged in 1825.—A medal of 1200 francs value, for researches on the origin of the various races of man spread over the islands of the ocean to the south-east of Asia.

15. *Eruption of a Mud Volcano in Sicily.*—An eruption of the volcano of Terrapilata, in Sicily, which occurred in March, 1823, was witnessed by D. Gregorio Barnaba La Via, who has described it in a geological account of the neighbourhood of Caltanisetta.

This volcano, not very different in its gaseous emanation from the famous Macalubba of Girgenti, and always in action, at a temperature of about 100° Fah.; forms, from its erupted matter, numerous small cones, from the centre of which, flow saline water, mud, and hydrogen gas. The surrounding land is quite steril presenting no traces of vegetation, from which circumstance, it takes its name. The author understood, from well-informed persons, that whenever Sicily has suffered from violent earthquakes, a crack, from two to more inches in width, has been observed commencing here; which intersecting the country, terminates under the Convent della Grazia, and to this is attributed the safety of Caltanisetta, which has never suffered from these terrible phenomena.

On the 5th of May, 1823, whilst the north wind blew in strong interrupted gusts, the sky being serene, a few dense clouds, in long pointed striæ, appeared in the west; the temperature was 53° Fah., when five shocks of an earthquake succeeded each other in nine seconds, the first from below upwards, the others undulatory. The author immediately went to the volcano of Terrapilata, in company with the Duke of Villarosa, Luigi Barrile, and the Abbate Salvatore Livolsi, all of whom had closely observed the place since 1818. On arriving at the place, it was found that the whole elevation was divided by numerous splits from ten inches to one foot and a half in width; that the small volcanoes were considerably increased; and that instead of ejecting water, clay, and hydrogen gas, as usual, some were throwing mud to the distance of seven feet, with the emission of gas; others only blew out hydrogen gas; and others again, leaving a space of a foot in diameter, and five feet deep, vibrated from that depth with the force of their eruptions.

Having applied a torch to one of these whistling cones, immediately a blue flame, five feet in height, arose, which would have

remained for a long time, but that the wind being powerful, extinguished it.

The crack was then noticed which had been first pointed out; it joined with the greater number of the small volcanoes, being about one and a half feet in width; intersected the valley of Scopatore and the border of the mountain of S. Anna, being there about four inches in width; cutting the quarter of Piedigrotta, it ascended to the Church of S. Flavia, about fifteen lines in width; and traversing the Convent della Grazia, terminated insensibly in the neighbourhood of the Church of S. Petronilla.

After five days of violent action during which there was no abatement, the eruption began gradually to diminish, and ultimately returned to its usual state.—*Giornale di Fisica*, vii. 124.

The annexed Prospectus has been sent us for insertion in this Journal.

Society of Physicians of the United Kingdom, established in London, June 17, 1824.

Although medicine has been studied from a very early period, and considerable genius and learning have been employed in its cultivation, yet such is the extreme complication and difficulty of the subject, that its present state still admits of great improvement; to which, perhaps, nothing would more effectually contribute, than the intimate union and active co-operation of its professors.

Much may certainly be accomplished by united effort, which individual exertion, however well directed, is unable to effect. While, at the same time, it cannot be doubted, that whatever contributes to the advancement of medical science, must by increasing its usefulness, add to the dignity of the profession.

Under these impressions, and considering that a great majority of the regular Graduates of Physic in this country are at present in an isolated state; several physicians practising in London have been induced to associate; and to invite the zealous co-operation throughout the kingdom, of that part of the profession to which they belong; with a confident hope of facilitating by these means, the accomplishment of the laudable purposes just mentioned.

It is therefore proposed that a Society be established having principally in view the follow objects:

1. The reception and discussion of subjects connected, in any manner, with the science of medicine.

2. The combined investigation of such points, whether theoreal or pratical, as are at present obscure or uncertain, and to the ucidation of which, individual labour has hitherto appeared indequate.

3. The publication of papers furnished by Members of the Society, or of those which may be transmitted to them, by the profession at large.

4. And in general the effecting of whatever may tend to improve the science of medicine, or to advance the interests and dignity of its professors, the regularly-educated Graduates in Physic of the Universities of the United Kingdom.

At a Meeting held, June the 17th, 1824, at the house of Dr. Shearman, present Drs. Temple, Cleverly, Birkbeck, Uwins, Clutterbuck, Hancock, Shearman, Copland, Tweedie, and Roberts,

It was resolved unanimously,

1. That a Society of Physicians be established for the purposes above stated.

2. That it be called "THE SOCIETY OF PHYSICIANS OF THE UNITED KINGDOM."

3. That the Society consist of such persons only as have actually prosecuted the study of Medicine in a University, for the period prescribed by its regulations, and who, having subsequently submitted to the usual tests and examinations, have thereby obtained the degree of Bachelor or Doctor of Physic. But Members of the London College, whether Fellows or Licentiates, admitted prior to the year 1800, are eligible.

4. That no person be a Member of this Society who is engaged in the actual practice of Surgery, Pharmacy, or Midwifery.

5. That a Committee be appointed for the purposes of giving the necessary publicity to these transactions; of receiving communications from the Profession; of preparing a system of laws and regulations for the government of the Society; and of performing, in general, whatever may be conducive to its interests, prior to the first General Meeting; to which they are to report proceedings, and resign their functions.

6. That the following Gentlemen be Members of this Committee, with the power of making such additions to their number as they may judge convenient:—

Committee—Drs. Temple, Cleverly, Birkbeck, Uwins, and Clutterbuck.

7. That the first General Meeting take place at the house of

Dr. Birkbeck, at half-past eight in the evening of the second Thursday in October next.

(Signed) C. J. Roberts, *Sec. pro temp.*

Communications on the subject of the Society to be addressed to Dr. Roberts, No. 20, Earl-street, Blackfriars.

ART. XV.—METEOROLOGICAL DIARY for the Months of June, July, and August, 1824, kept at EARL SPENCER'S Seat at Althorp, in Northamptonshire.

The Thermometer hangs in a North-eastern Aspect, about five feet from the ground, and a foot from the wall.

For June, 1824.

		Thermometer.		Barometer.		Wind.	
		Low	High	Morn.	Eve.	Morn.	Eve.
Tuesday - - -	1	51	73	29.95	30.03	NW	NNW
Wednesday -	2	50	75	30.20	30.18	NbW	N
Thursday - -	3	50	62	30.20	30.22	NE	EbN
Friday - - - -	4	44	62	30.22	30.19	EN E	NE
Saturday - -	5	46	56	30 18	30.13	ENE	NE
Sunday - - -	6	49	62	30.10	30.08	NE	NE
Monday - - -	7	50	68	30.05	30.00	E	NW
Tuesday - - -	8	45	76	30.00	29.97	NW	NE
Wednesday	9	46.2	67	29.94	29.87	E	NE
Thursday -	10	48	63	29.80	29.85	E	NE
Friday - - - -	11	47	60	29.95	30.00	NE	NE
Saturday -	12	43	62	30.05	30.00	NE	NE
Sunday - -	13	36	69	30.00	29.80	ESE	SbE
Monday - -	14	49	69	29.40	29.20	SbE	SbE
Tuesday - -	15	53	60	29.15	29.20	E	SE
Wednesday -	16	48	65	29.40	29.50	E	NNE
Thursday - -	17	51	62	29.61	29.80	NE	NE
Friday - - - -	18	37	64	29.90	29.80	NE	W
Saturday - -	19	45	56	29.68	29.37	SE	ESE
Sunday - - -	20	52	65	29.30	29.25	SE	SE
Monday - -	21	50	66	29.30	29.38	SW	SW
Tuesday - - -	22	46	58	29.40	29.40	WbS	EbS
Wednesday -	23	53	54	29.37	29.30	E	E
Thursday - -	24	52	57	28.33	29.40	N	N
Friday - - -	25	52	65	29.53	29.69	W	W
Saturday - -	26	48	72	29.85	29.88	WbN	W
Sunday - - -	27	43	71	29.88	29.81	SE	SSE
Monday - - -	28	53	75	29 80	29.78	SE	SW
Tuesday - -	29	52	75	29.67	29.50	SSE	W
Wednesday -	30	50	71	29 69	29.70	W	W

For July, 1824.

		Thermometer.		Barometer.		Wind.	
		Low	High	Morn.	Eve.	Morn.	Eve.
Thursday - -	1	51	72	29.81	29.62	W	WSW
Friday - - - -	2	55	72	29 43	29.43	W	SW
Saturday - -	3	55	71	29.46	29.46	WSW	WSW
Sunday - - -	4	53	68	29.55	29.75	W	W
Monday - - -	5	46	70	29.80	29.82	W	WbN.
Tuesday - - -	6	50	65	29 82	29.72	W	SSE
Wednesday -	7	55	69	29.72	29.65	S	W
Thursday - -	8.	55	72	29.80	29.84	W	W
Friday - - -	9	52	70	29.84	29.79	W	W
Saturday - -	10	49	72	29.79	29.83	W	WbN
Sunday - - -	11	48	75	29.90	29.88	SW	W
Monday - - -	12	58	76	29.88	29 88	W	W
Tuesday - - -	13	54	76	29.88	29.90	W	W
Wednesday -	14	55	82	29.84	29.76	W	SW
Thursday - -	15	60	80	29.77	29.81	W	WbS
Friday - - - -	16	55	79	29.93	29.97	W	W
Saturday - -	17	50	75	30.10	30.13	NW	NNW
Sunday - - -	18	53	73	30.13	30.20	NE	EbN
Monday - - -	19	50	68	30.31	30.32	W	NW
Tuesday - - -	20	52	73	30.30	30.24	W	NW
Wednesday -	21	52	74	30.18	30.18	NW	E
Thursday - -	22	53	76	30.16	30.11	E	WSW
Friday - -	23	55	78	30,09	29 96	SW	SW
Saturday - -	24	57	77	29.82	29.72	W	W
Sunday - - -	25	55	72	29.72	29.77	NE	WbN
Monday - - -	26	58	70	29.77	29.77	NE	NE
Tuesday - - -	27	50	70	29.87	30.03	NbE	NE
Wednesday -	28	43	73	30.14	30.10	NE	W
Thursday - -	29	42	75	30.06	29.90	WbS	SE
Friday - - - -	30	42	73	29.70	29.51	SE	ENE
Saturday - -	31	47	72	29.58	29.60	E	E

For August, 1824.

		Thermometer.		Barometer.		Wind.	
		Low	High	Morn.	Eve.	Morn.	Eve.
Sunday - - -	1	54	63	29.63	29.81	NE	EbN
Monday - - -	2	41	74	29.93	29.90	ENE	SW
Tuesday - - -	3	50	71	29.89	29.86	SW	WSW
Wednesday -	4	51	73	29.80	29.70	SE	W
Thursday - -	5	55	72	29.63	29.60	SW	SW
Friday - - - -	6	55	65	29 53	29.60	SW	SW
Saturday - -	7	53	71	29.67	29.82	NNW	NNW
Sunday - - -	8	54	69	29.78	29.70	SW	SW
Monday - - -	9	61	74	29.60	29.60	W	W
Tuesday - - -	10	52	74	29.71	29.70	W	WbS
Wednesday -	11	55	70	29.56	29.60	SW	WbS
Thursday - -	12	53	70	29.65	29.66	WbS	W
Friday - - -	13	50	72	29.73	29.75	W	W
Saturday - -	14	48	71	29.85	29.87	W	W
Sunday - - -	15	55	70	29.60	29.48	WSW	W
Monday - - -	16	51	71	29.55	29.67	W	W
Tuesday - - -	17	49	74	29.70	29.58	W	WbS
Wednesday -	18	50	70	29.55	29.45	WbS	W
Thursday - -	19	49	68	29.63	29.69	W	W
Friday - - -	20	52	70	29.69	29.73	W	W
Saturday - -	21	55	70	29.70	29.71	W	W
Sunday - - -	22	53	63	29 92	29.99	NE	NNE
Monday - - -	23	45	68	30.03	30.03	WbN	NW
Tuesday - - -	24	46	71	30.08	30.10	NW	E
Wednesday -	25	47	77	30.18	30.19	EbS	ENE
Thursday - -	26	58	68	30.23	30.21	E	NE
Friday - - - -	27	56	67	30.21	30.12	NE	NE
Saturday - -	28	55	73	30.00	29.85	E	EbS
Sunday - - -	29	53	77	29.83	29.80	NE	EbS
Monday - - -	30	53	72	29.80	29.80	NNE	EbN
Tuesday - -	31	59	69	29.80	29.82	NE	NE

The First Course *of these Lectures will commence on* Tuesday, *the* 5th of October, *at Nine in the Morning precisely. The* Second Course *will begin on the* Second Tuesday *in* February, *at the same hour.*

The Royal Institution.

ALBEMARLE-STREET.

PLAN

OF AN EXTENDED AND PRACTICAL COURSE OF LECTURES AND DEMONSTRATIONS ON

CHEMISTRY,

DELIVERED IN THE LABORATORY OF THE ROYAL INSTITUTION,

BY WILLIAM THOMAS BRANDE, F.R.S.,

Secretary of the Royal Society of London, and F.R.S. Edinburgh ; Professor of Chemistry in the Royal Institution, and of Chemistry and Materia Medica to the Apothecaries' Company.

AND

M. FARADAY, F.R.S., &c.

These Lectures commence on the FIRST TUESDAY in OCTOBER, at Nine in the Morning, and are continued every Tuesday, Thursday, and Saturday. Two Courses are given during the Season, which begins in October, and terminates in June.

The Subjects comprehended in the Courses are treated of in the following order.*

DIVISION I.

OF THE POWERS AND PROPERTIES OF MATTER, AND THE GENERAL LAWS OF CHEMICAL CHANGES.

§ 1. Attraction—Crystallization—Chemical Affinity—Laws of Combination and Decomposition.

§ 2. Heat—Its Influence as a Chemical Agent in Art and Nature.

§ 3. Electricity—Its Laws and Connexion with Chemical Phenomena. § 4. Radiant Matter.

DIVISION II.

OF UNDECOMPOUNDED SUBSTANCES, AND THEIR MUTUAL COMBINATIONS.

§ 1. Substances that support Combustion: Oxygen—Chlorine—Iodine.

§ 2. Inflammable and Acidifiable Substances Hydrogen—Nitrogen—Sulphur—Phosphorus—Carbon—Boron.

§ 3. Metals—and their Combinations, with the various Substances described in the early part of the Course.

DIVISION III.

VEGETABLE CHEMISTRY.

§ 1. Chemical Physiology of Vegetables.

§ 2. Modes of Analysis—Ultimate and proximate Elements.

§ 3. Processes of Fermentation, and their Products.

DIVISION IV.

CHEMISTRY OF THE ANIMAL KINGDOM.

§ 1. General Views connected with this Department of the Science.

§ 2. Composition and Properties of the Solids and Fluids of Animals.

§ 3. Products of Disease. § 4. Animal Functions.

DIVISION V.

GEOLOGY.

§ 1. Primitive and secondary Rocks—Structure and Situation of Veins.

§ 2. Decay of Rocks—Production of Soils—Their Analysis—Principles of Agricultural Improvement.

§ 3. Mineral Waters—Methods of Ascertaining their Contents by Tests and by Analysis.

§ 4. Volcanic Rocks—Phenomena and Products of Volcanic Eruptions.

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* Mr. BRANDE's MANUAL OF CHEMISTRY, intended as a Text Book to these Lectures, is published by Mr. Murray, Albemarle-Street.

In the FIRST DIVISION of each Course, the principles and objects of Chemical Science, and the general Laws of Chemical Changes are explained, and the phenomena of Attraction, and of Light, Heat, and Electricity developed, and illustrated by numerous Experiments.

In the SECOND DIVISION, the undecompounded bodies are examined, and the modes of procuring them in a pure form, and of ascertaining their chemical characters, exhibited upon an extended scale. The Lectures on the Metals include a succinct account of Mineralogy, and of the methods of analyzing and assaying Ores.

This part of the Course will also contain a full examination of Pharmaceutical Chemistry; the Chemical Processes of the Pharmacopœiæ *will be particularly described, and compared with those adopted by the Manufacturer.*

The THIRD and FOURTH DIVISIONS relate to Organic Substances. The Chemical changes induced by Vegetation are here inquired into; the principles of Vegetables, the Theory of Fermentation, and the character of its products, are then examined.

The CHEMICAL HISTORY of ANIMALS is the next object of inquiry—it is illustrated by an examination of their component parts, in health, and in disease; by an inquiry into the Chemistry of Animal Functions, and into the application of Chemical principles to the treatment of Diseases.

The Courses conclude with an ACCOUNT OF THE STRUCTURE OF THE EARTH, of the Changes which it is undergoing, of the objects and uses of Geology, and of the princples of Agricultural Chemistry.

The applications of Chemistry to the Arts and Manufactures, and to Economical Purposes, are discussed at some length in various parts of the Courses; and the most important of them are experimentally exhibited: The various operations of Analysis are also shewn and explained.

The Admission Fee to each Course is Four Guineas; *or, by paying* Eight Guineas, *Gentlemen are entitled to attend for an unlimited time. Gentlemen, who are in actual attendance at the Medical and Anatomical Schools in London, are admitted to attend Two Courses of the above Lectures, upon the payment of* Six Guineas. *Life and Annual Subscribers to the Royal Institution are admitted to the above Lectures, on payment of* Two Guineas *for each Course; or, by paying* Six Guineas, *are entitled to attend for an unlimited time.*

Further particulars may be had by applying to Mr. BRANDE, No. 20, Grafton-street; or at the Royal Institution, Albemarle-street.

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ART. I.—*Results of Experiments relating to the comparative means of Defence afforded by Ships of War, having Square and Curvilineal Sterns. By* George Harvey, Esq., F.R.S.E., M.G.S., *&c.*

[Communicated by the Author.]

ALTHOUGH it would be possible to deduce *à priori,* the comparative means of defence afforded by ships of war having square and curvilineal sterns, and to shew by a train of unquestionable reasoning, that the new form latterly introduced into His Majesty's navy, by Sir Robert Seppings, is calculated to benefit and improve every class of vessels to which it may be applied, both as regards strength and means of defence;—yet, on a subject of so very practical a nature, and so intimately identified with the most important interests of the country, a course of exact and intelligible experiments, may be considered in every point of view, by the gallant members of the naval profession, who must necessarily be regarded as the best and most proper judges of the subject, as affording results much more satisfactory and conclusive, than could possibly be deduced, even from the clearest abstract and hypothetical reasoning.

Fully impressed with the truth and importance of this view of the subject, and residing in a naval port, where it is necessarily regarded with great interest and attention, and where for a consi-

derable period it has formed a theme for keen and animated discussion, I conceived that an appeal to actual experiment, performed on board two ships of war of the same class, having sterns of the old and new forms, would be likely to throw some light on the question; and perhaps remove some of those erroneous impressions which unquestionably exist, respecting the nature and properties of the curvilineal stern. Accordingly a course of comparative experiments was undertaken, on board the Boadicea and Hamadryad frigates, being ships of the same rate, each mounting 46 guns, the former having a stern of the old or square form, and the latter one of the new or curvilineal kind.

In the prosecution of these experiments, I fortunately received the voluntary assistance and advice, of several distinguished naval officers*, who necessarily took an interest in the inquiry; and who, by particularly attending to the different bearings of the guns, determined in the course of the investigation, and by discussing the merits of each position, with freedom and candour, enabled me ultimately to obtain a series of accurate and important results; and which will, I trust, place the means of defence afforded by the curvilineal stern, in a striking and imposing point of view, when contrasted with the feeble resistance capable of being afforded by sterns of the ancient form†. This plan of procedure, although necessarily tedious and slow, was, nevertheless, the only one that could be satisfactorily pursued, in order to impart to the experiments all the accuracy desired; and which should, moreover, enable a fair and an unexceptionable comparison to be made of the means of defence afforded by the two forms.

In determining the different bearings of the guns, particular care was taken in every instance to prevent their being wooded; and

* I record with pleasure the kind assistance I received in particular from my friend Captain Wise, R.N., both as regards the performance of the experiments, and the execution of the various drawings in his Majesty's dock-yard at Plymouth, to illustrate them.

† The present paper being confined entirely to a consideration of the means of *defence* afforded by the curvilineal stern, it is my intention to investigate, in another essay, in what degree the entire frame of a ship is strengthened by this judicious and important improvement.

also to afford room for an ample recoil, excepting in one position in the square stern, where the space behind the gun was somewhat confined, in order to obtain an increased amplitude in the bearing; but which case will be referred to, in the order in which it occurs.

The moment the position of a gun was finally determined, its bearing was carefully laid down on the deck, and referred to a longitudinal line, passing through the middle section of the ship. And in order to give every possible advantage to the square stern, the ports of the Boadicea submitted to experiment, were entirely stripped of their linings, so as to present only the naked timbers; whereas in the ship with the curvilineal stern, the linings were in every case preserved, and which therefore gave to the square form, a very considerable advantage during the comparison; but even with this advantage, it will be found, that the means of defence it afforded were decidedly inferior to those presented by the curvilineal form.

For the purpose of comparing the different bearings of the guns, determined in the course of the experiments, on board the two frigates, two points K,K, figs. 1 and 2, plate III, were assumed in the longitudinal axis X Y of the vessels, at the distance of 17 feet from the after part of the counter of the square stern, and also from the after part of the lower stool of the curvilineal stern. From these points as centres, and with radii of 27 feet, two arcs of circles *a b c c b a*, *a b e f f e b a* were described, the former surrounding the square stern, and the latter that of the curvilineal form. To these circumferences, the various arcs or ranges swept over by the guns, in their transition from one bearing to another, were in all cases referred.

The first experiments performed, were on board the Boadicea, or square-stern vessel. An eighteen pounder was placed at the after broadside-port, and trained to its greatest possible angle *before* the beam, as denoted by the lines A *a*, fig. 1, plate III, or fig. 1, plate IV; forming in the first-mentioned figure, an angle *a* A Y of 61°, with the principal longitudinal axes X Y of the vessel; the outer extremity of the muzzle of the gun, being at the same time within the external edge of the port four inches. This bearing

having been determined, the gun was next brought into the position denoted by the line B b, fig. 1, plate III *, being the greatest possible angle at which it could be trained, *abaft* the beam; the line of fire forming with the principal axes of the vessel, the angle b B X of $35\frac{1}{2}$°. The arc $a\,b$, intercepted between the two bearings, amounted to 46°; and hence it follows, that an object placed in any part of it could be hid by a shot from the after broadside-port, confined of course to the limits prescribed, by the ordinary charge of powder. The circular dots introduced in the arc $a\,b$, as also in all the arcs which may hereafter be alluded to, are designed to indicate, that every part of the space contained between the extreme bearings can be defended.

The exact position of the point b having been determined by the last experiment, the gun was next removed to the adjacent port in the stern, and trained to its greatest possible angle, as denoted by the line Cc † fig. 1, plate III, or fig. 2, plate IV, and forming with the axis X Y, the angle c C X of $32\frac{1}{2}$°. To obtain this bearing, the muzzle of the gun was brought four feet *within* the forepart of the rail, creating thereby great danger from fire. It will also be observed, by referring to the former figure, that the truck of the gun was brought into contact with the rudder-head; so that the utmost bearing was determined.

This being the greatest bearing that could be obtained with a stern gun, directed towards the adjacent quarter of the ship, necessarily left the arc $b\,c$ Fig. 1, plate I, amounting to $32\frac{1}{2}$°, *entirely undefended;* and it was also remarked, that the bearings B b and C c, were not in directions parallel to each other, but in a state of divergency, amounting to three degrees; and that therefore the extreme lines of fire proceeding from the after broadside-port, and the adjacent port in the stern, could not under the present circum-

* A similar bearing is represented in B b, Fig. 1, Plate IV., with the gun delineated; it not being possible to introduce both bearings at the *same* port, at the same time.

† It would appear from the diagrams, that the line of fire C c, would carry away the angles of the stern-ports. This, however, cannot be the case, since the part which it apparently crosses is *above* the line of fire.

stances, be made to "*cross,*" and consequently, that a "*point of impunity*" necessarily existed.

Desirous however of discovering, if it would be possible under any circumstances, consistently with the preservation of the frame of the ship, to make the lines of fire issuing from the last-mentioned ports intersect each other, an estimate was made, to determine what alteration would be produced in the bearing of the gun, at the stern-port, by supposing the rudder-head to be removed; since such an alteration, would necessarily have the effect of changing the direction of the line of fire C *c*, by causing it to approximate in some degree to the direction B *b*. The utmost difference, however, that could be produced by this arrangement, in the bearing of the gun, amounted only to a diminution of a degree and a half of the divergence before determined; the new line of fire being in the direction E *e*, and which therefore still kept the bearings of the two guns from a state of parallelism, and consequently preserved a "point of impunity" between them.

The undefended arc *b c*, was of course diminished, by the same quantity, as the divergence of the stern-gun was altered, the arc *b e* amounting in this new condition to thirty-one degrees. Hence it appears, that the lines of fire proceeding from the after broadside-port, and the adjacent port in the stern, cannot be made to cross, even when the rudder-head is removed, unless by destroying one of the sides of the former port, or a part of the stern-frame; and that a point of impunity therefore exists, on the quarter of a square stern,* which it is impossible altogether to remove, unless by

* It may perhaps be urged against this train of observation, that a point of impunity can scarcely be said to exist *practically*, when the divergence of the lines of fire is so small, and their distance, at their origin, so inconsiderable. But, it should be remembered, that in these experiments the *utmost* limit was given to the bearings of the guns; and that to obtain the extreme lines of fire above alluded to, much more time and labour was consumed, than could reasonably be afforded in the day of battle; and that therefore the divergence of the lines of fire from each other may be fairly considered, in a *practical* point of view, to be *greater by many degrees* than the quantity above determined; and consequently that the existence of the point of impunity will be rendered propor-

injuring very materially the strength of the ship. It is proper however to add, that by removing the rudder-head, the gun could be run out twenty-one inches farther than when it was in its former position, which must be regarded as an advantage, since it diminishes, in some degree, the danger of fire.

The next position assumed for the gun, was that of D *d*, Fig 1, plate III, forming with the principal axis X Y, the angle *d* D Y of 27°; this direction affording the greatest possible bearing at the stern, towards the opposite quarter of the ship, when the recoil was limited to four feet*. The magnitude of the arc *c d*, between the extreme bearings at the stern-port, was therefore found to be $30\frac{1}{2}°$, when the rudder-head was preserved; but nearly a degree more when it was removed. In this situation, however, the muzzle of the gun was still farther *within* the stern, than determined in the preceding experiment.

From the foregoing experiments, it therefore appears that the entire arc *a b d b a* surrounding the square stern, and which amounts in quantity to 204°, may be separated into the

$$\text{three defended arcs } \begin{cases} a\,b = 46° \\ c\,c = 47° \\ a\,b = 46° \end{cases}$$

amounting together to 139°; and into the

$$\text{two undefended arcs } \begin{cases} b\;c = 32\tfrac{1}{2}° \\ b\;c = 32\tfrac{1}{2}° \end{cases}$$

amounting jointly to 65°; the sum of the defended and undefended arcs being 204°, as before mentioned. Of the defended arcs, it may be observed, that the first and last *a b*, *a b*, admit of a ready

tionably certain, according to the degree in which the divergence of the lines of fire is increased; and which in every practical case will be much more considerable than what was stated above. It may also be remarked, that in order to obtain the extreme lines of fire for the stern-guns, the muzzles were brought so very far *within* the framework of the stern, as to render it, in the opinion of the naval gentlemen present, extremely dangerous to fight the gun under such circumstances.

* In such an application of a gun, the breeching must be so ordered, as to prevent a greater recoil.

defence in any part, from either of the after broadside-ports; but the second, or right aft portion *c c*, cannot be defended in every part, from the stern-ports, with the same convenience and security from fire.

For the purpose of affording a more explicit reference to the different bearings of the guns, above referred to, the following table is added; of which, the first column denotes the several angles formed by the lines of fire, with the principal axis of the ship; and the second, the distances of the points of intersection formed by the respective lines of fire and the same axis, reckoned from the point K, the centre of the circular arc, *a b* c c *b a* surrounding the stern as a common origin.

Magnitudes of the angles formed by the respective lines of fire, and the axis XY.	Distances of the points of intersection of the lines of fire, with the axis XY, reckoned from the common origin K.
aAY = 61°	KA = 9·0 feet
bBX = 35°½	KB = 16·7
cCX′ = 32°½	KC = 8·5
dDY = 27°	KD = 20·5

Having considered the effects capable of being produced by guns in the before-mentioned positions, when applied *singly*, an inquiry may in the next place be undertaken, to determine the results of their *joint* action.

Suppose in the first place, therefore, a square-stern vessel to be attacked at the same instant, both on the stern and starboard quarter; it is evident, that it would not be possible to fight the after broadside-gun, directly a-beam, and the adjacent stern-gun right aft, at the same time; since the distance between the trains of the carriages, when completely run out, would only amount to fifty inches; and which when the recoil takes place, would necessarily bring the carriages into contact with each other. One of three

things must therefore be done, in a case of this nature;—either the former gun must be trained abaft the beam;—the fire of the latter be brought nearer to the quarter of the ship attacked;—or the latter gun be removed, and fought at the other stern-port. It might be possible also to fight both the after broadside-guns, by training them abaft the beam, with both the stern-guns directed right aft;—but as before shown, under no circumstances, can the lines of fire be made to cross each other, on the quarters of the ship;—a point so much to be desired, on many difficult and trying occasions.

The utmost advantage indeed that can be obtained from crossing the lines of fire, must in strictness be limited to a single combination, produced by the stern-guns immediately abaft, and confined to the space between the lines of extreme fire *d* D *k*, *d* D *k* Fig 1, plate III. It is true, by forming new lines of bearings for the guns, within the limits here referred to, an indefinite number of intersecting points may be created;—still it is obvious, that only *one* can be obtained at the *same* time. For example, a point of cross-fire may be found at D, produced by the extreme lines of fire;—or by gradually approximating those bearings to each other, other points in the axis X Y may be determined, more distant from the stern, thereby commanding the sectorial space D *g g*. So also, other points may be found, out of the principal axis, by corresponding bearings of the guns. Thus, the points *g*, *g* may be determined, by combining either of the right aft lines of fire I *i*, I *i*, with one of the extreme lines of fire *d* D, *d* D, and sweeping over, by different modifications of these lines of fire, the sectorial spaces *g i k*, *g i k*. In like manner by varying the bearings of the guns, may any number of points of intersection be determined within the bounds of extreme fire;— but only *one*, as before remarked, can be determined at the *same* time. Thus, the advantage of a cross fire, which in military purposes is always of so much moment and importance with respect to the square stern, is limited and confined in an extreme degree.

From the preceding considerations, it therefore appears, that the defence of the square stern is subject to the following disadvantages:

First,—*Two considerable arcs exist on the quarters, incapable of*

being defended; and hence a point of impunity is created, from the impossibility of crossing the lines of fire, which proceed from the after broadside-gun, and either of the stern-guns.

Secondly, —*That to defend even an arc of* 47°, *right aft, produces much inconvenience, and a considerable waste of time, from the difficulty of obtaining the requisite positions for the guns, in consequence of the rudder-head, and the projecting timbers of the stern.*

Thirdly, —*That in defending the before-mentioned arc, the dangers of fire are very considerable, from the muzzles of the guns being so very much* within *the whole of the stern-frame.*

Fourthly.—*That only* one *point of cross-fire can be found, at the* same *time, in any part surrounding the square stern.*

Such are the limits which are therefore prescribed to the defence of the square stern, from its peculiarly disadvantageous form; the difficulties and disadvantages of which can only be surmounted by the *general* and efficient * application of the curvilineal stern.

The preceding conclusions having been obtained for the square stern, we shall in the next place proceed to the consideration of the experimental results obtained for the curvilineal stern †.

* I employ the term *efficient,* because attempts have been made to accommodate the *new* form to the old; to retain the *appearance* of the *latter,* and to obtain, if possible, the advantages of the *former;*—points very desirable to be obtained unquestionably, but which require great skill and consideration for their determination;—since it is possible that, in order to gratify the eye, which has been educated to admire a particular form as the most beautiful, the soundest maxims of mechanical knowledge may be sacrificed, and also the most important principles of defence. The history of science proves the accommodation of theories to be next to useless. Nature has but one mode of working, and that can never be obtained by the union of erroneous principles with truth.

† All the bearings hereafter mentioned, were determined with the ports in their ordinary state; no linings having been stripped from them to increase their width, as was done in the experiments on board the Boadicea. It was considered unnecessary in the case of the Hamadryad, because the very superior means of defence afforded by her curvilineal stern, could be most strikingly displayed without removing them. As remarked, however, in a preceding page, this difference in the mode of conducting the experiments, gave

The first bearing determined on board the Hamadryad, was at the after broadside-port, an eighteen-pounder being trained to the greatest possible angle *before* the beam the position would admit, without wooding. The line of fire *a* A, Fig. 2, Plate III, or Fig. 3, Plate IV, so produced, was found to form with the principal axis X Y, an angle *a* A Y of 53°;—the outer extremity of the gun being at the same time coincident with the side of the vessel. From this direction, the gun was trained into that of *b* B, *abaft* the beam, Fig 2, Plate I*, being likewise the greatest deviation from the line of direct fire the case would admit, without wooding. This line of fire, formed with the principal axis X Y, an angle *b* B X of 36°; the outer extremity of the muzzle being, at the same time, two inches within the external edge of the port. The arc *a b* thus swept over by the gun, during its translation from the first-mentioned position to the second, amounted to $48\frac{1}{2}$°, every part of which admitted of a ready and effectual defence.

A gun was in the next experiment, placed at the port in the adjacent quarter of the ship; the part of the square stern-vessel, which was proved in the preceding experiments, to be entirely undefended, but which, in the curvilineal stern, was found capable of making a vigorous defence. To prove this the first bearing determined, was in the line C *c*, *before* the beam, Fig 2, Plate III, or Fig 3, Plate IV, forming with the axis X Y, the angle *c* C Y of 78°, being the greatest the position would admit, without wooding the gun, or limiting the range of its recoil. The extremity of the axis of the gun also coincided with the external edge of the port. From this position, the gun was removed into that of D*d*, *abaft* the beam, Fig 2, plate III, its direction forming with the principal axis, the angle *d* D X of $16\frac{1}{2}$° the gun having been found capable of sweeping the arc *c d* of 46°, with perfect freedom. In this last situation, the outer part of the muzzle was found only an inch within the outer edge of the port.

The next situation assumed for the gun, was in the adjoining stern-port, where the ease with which it was worked, afforded a striking contrast to the difficulties experienced in the square stern,

a considerable advantage to the square stern; but which only served to place in a more striking point of view the superiority of the new form.

* A similar position is shewn in Fig. 2, Plate IV., with the gun delineated.

and called forth the repeated and warm eulogiums of the officers present. Instead of having the projecting timbers of the stern-frame, and the rudder-head to contend with, in determining the different positions of the guns, as in the experiments performed on the deck of the Boadicea;—or the danger of blowing out the entire stern-frame *, or of occasioning fire in the vessel, both of which are possible in the case of a vigorous contest, from the muzzle of the gun, when trained right aft, being three feet *within* the stern-frame; the gun in the curvilineal stern could be worked, as truly remarked by Capt. Wise, with all the ease and convenience of one at a broad-side-port; and that moreover when it was trained right aft, its muzzle was found to project considerably *beyond* the stern-frame:—thus reducing the chances of fire to those of a broadside-port; whereas in the square stern, they would be increased, under similar circumstances, very much beyond them.

The first bearing determined at the last-mentioned port was in the direction E *e*, Fig. 2, Plates III and IV towards the adjacent quarter of the ship, and forming with the axis, X Y, an angle *e* E X, of $48\frac{1}{2}^\circ$, being the greatest angle from the line of the keel, at which the gun could be trained. The extremity of the gun was an inch within the

* That the blowing out of a square stern is not an hypothetical case, but has in some instances been rendered absolutely necessary, from its imperfect and injudicious form, may be proved by a reference to the gallant action of the Blanche with La Pique, in which the main and mizen-masts of the former "being shot away, and head-sails filling, she payed off before the wind, thus "bringing La Pique astern, towing by the bowsprit. The Blanche was "immediately much annoyed from her quarter-deck guns, which were well "served, and pointed forward, without the English frigate being able to "return a gun, having *no stern-ports* on her main deck." The gallant commander had no alternative left but to blow out the stern-frame. To accomplish this, all the firemen, with their buckets, were assembled in the cabin, and both the after-guns pointed against the stern, which made a clear breach on both sides, the fire occasioned by the execution of this prompt and judicious plan being immediately extinguished. The La Pique was now raked with great effect, her decks being cleared fore and aft, and soon after she surrendered. An officer remarks, who distinguished himself in this gallant action, that if the expedient of blowing out the stern-frame had not been adopted, the most serious consequences might have been apprehended; at all events, the loss of many men.

outer edge of the port; and the direction of the shot passed quite clear of the adjacent water-closet. From this situation, the gun was turned towards the opposite quarter of the ship, the line of fire *f* F, forming with the axis X Y Fig 2, Plate III, the angle *f* F Y of 30°, the gun having swept over the arc *e f* of 43°, without the smallest difficulty of any kind. Hence it appears, that the entire range of the arc *af*, from the point *a* where the limiting fire of the after broadside-gun commences to the point *f*, where the utmost limit of the adjacent stern-gun is obtained, is capable of being assailed by an efficient and vigorous fire, from either of the ports here alluded to, or from the port in the quarter of the stern; and that moreover, the weakness of the quarter, which in the square stern has always formed so essential and important an objection, in the curvilineal stern is entirely removed. It may also be added, that when the gun was trained in the last-mentioned position, its muzzle was only an inch within the outer edge of the port. It will likewise be remarked that the line of fire passes entirely clear of the dressing-room.

For the purpose of a more convenient reference, the following table is added, the first column of which contains the different angles formed by the lines of fire with the principal axis of the ship; and the second, the distances of the points of intersection formed by the same lines of fire with the axis, reckoned from the point K, the centre of the circular arc *a b e f f e b a* which surrounds the stern.

Magnitudes of the angles formed by the respective lines of fire, and the axis XY.	Distances of the points of intersection of the lines of fire wth the axis XY, reckoned from the common origin K.
*a*AY = 53°	KA = 10·4 feet
*b*BX = 36°	KB = 18·3
*c*CY = 78°	KC = 10.2
*d*DX = 16½°	KD = 28·2
*e*EX = 48½°	KE = 8 4
*f*FY = 30°	KF = 19·8
*g*GY = 65°	KG = 6·2
*h*HX = 42½°	KH = 3·7
*i*IX = 24¼°	KI = 16·4
*k*KX = 90°	K = 0·0
*l*LX = 90°	KL = 7.8

Having ascertained the effects capable of being produced by the separate actions of the guns, it will be necessary, in the next place, to consider, as in the case of the square stern, the advantages likely to result from their combined application.

In the first place, it may be remarked, that the points of cross-fire are much more numerous than in the case of the square stern; and moreover, that they may be increased *ad libitum*, by varying the bearings of the guns, and which the very convenient form of the stern will permit to be done, with so much ease and convenience.

In the next place, it may be observed, that the close approximation of the same points to the parts of the vessel from which the lines of fire issue, is worthy of particular observation. The after broadside-port, for example, may be made to cross its fire with the gun in the quarter-port, at the point *n*, Fig 2, Plate III, being little more than two thirds of a fathom, from the side of the vessel;—thereby subjecting every part of the sectorial space *n o p*, containing an angle of 66°, and consequently the space beyond it, to the galling action of a cross-fire. In like manner, with the stern and quarter guns, it is possible to make the lines of fire intersect each other at *d e*, the distance being less than two fathoms from the quarter of the ship; and therefore exposing every part of the sector *d i s*, whose angle is $31\frac{1}{2}$°, and the space beyond it, to the operation of a cross-fire, at all distances between the utmost range of the gun, and the point of intersection last alluded to. The close approach of these points to the side and quarter of the vessel, was such as to excite the surprise of all who witnessed the experiment. In a cross-fire proceeding from the stern-ports, the superiority was equally apparent; the point of intersection F, being found within a fathom of the stern-frame, and the sector F *m m* containing an angle of 60°, every part of which was completely commanded.

A more striking example of the advantage which the curvilineal stern affords, for producing points of cross-fire, may however be exemplified, when a ship of this kind is attacked on her quarter. In such a case, the lines of fire proceeding from the after broadside-port, and from the adjacent quarter and stern ports, may all

be brought to bear on the *same point* y, within less than twelve fathoms of the quarter; the lines of fire being respectively B y, H y, and E y, Fig 2, Plate III. In Fig 2, Plate IV, the guns are represented in the positions necessary to produce this important effect; and where, it will be perceived, that the most ample space is afforded for working them. Hence it follows, that the quarter, which, in the old form of the stern, was decidedly the weakest part of the ship, in the curvilineal stern possesses the most ample means of defence.

A like important defence may also be created, supposing it should be necessary at any time, to concentrate the lines of fire in some point nearer the principal axis of the vessel; as the point Z for example, Fig 2, plate III. To accomplish this, the guns at both the stern and quarter ports may be employed at the same time, with sufficient space of working them; the lines of fire being D z, S z, and f z, the point where they unite being only twelve fathoms from the stern.

Such are the effects capable of being produced, by the extreme bearings of the lines of fire hitherto described; but it is evident many varieties may be created, to meet the diversified circumstances, under which ships of war are liable to be placed. In the first place, both the stern-guns may evidently be fought right aft, at the same time, the lines of fire M m, M m, being in such a case parallel; secondly, one of the last-mentioned guns may be fought right aft, and the other trained to any angle, between the line of fire M m, and the limit f F; the sectorial figure $m\ w\ x$, containing an angle of 30°, produced by the first-mentioned bearing, and the limit just alluded to being swept over in such a case. By varying the bearings of these guns, sectorial spaces may be ranged over, of any magnitude, within the limits of the extreme bearings f F, fF.

It would be possible moreover, to fight the guns at the adjacent stern and quarter ports, as indicated by the bearings Ei, and I i, the lines of fire intersecting in i, and commanding the sector $i\ u\ v$, whose angle amounts to 24°. It is evident also, that by causing the line of fire I i, to approximate towards H h, successive sectors will be created, at every new point of intersection. So likewise,

the bearings of C *c* and B *b* may be changed, and an indefinite number of new points determined, between the limits L *l* and K *k*. Thus the line of fire C *c* may be altered into that of L *l*, commanding in conjunction with the bearing B *b* the sector *l q r*, whose angle amounts to 53°. Or the direction B *b* may be transformed into any other, as K *k*, intersecting the bearing C *c* when both are produced.

Any force, therefore, that may be employed in attacking a ship with a curvilineal stern, will meet with a resistance of a much more formidable kind, than if its energies were expended on a square stern. If we compare for example the after broadside-ports of a ship of each sort, we shall observe that, in the old form, the insulated fire of a single gun is all the effect that can be produced; whereas in the curvilineal stern, the gun at the quarter-port can lend the most effectual aid, and by causing different discharges to converge to the same point, dispense a destructive cross-fire over a very considerable range. And this contrast is increased in a still more remarkable degree, when we compare the conditions of the quarters; since in the new stern, the means of defence, for the same space, are quite equal to those of any other part of the ship, but in the square form vanish altogether. In like manner, if the attacking force were situated directly a-stern, a much more effectual defence could be created, by means of the former, than could possibly be afforded by the latter, from the great facility it affords in working the guns, and the assistance that may in some cases be obtained from the quarters.

Hence it appears, that even in a greater arc than a semicircle, may points of cross fire be produced about the curvilineal stern; thereby throwing around this important part of a ship the energies of a formidable and perfect defence, and produced by means at once practicable and secure; leaving no point of impunity open to an acute and enterprising enemy, as in the case of the square stern, or any abrupt transition, from a well-defended part, to one feeble and insecure.

As a more particular reference may be necessary to the positions of the points of cross-fire, the following table has been prepared.

The first column indicates the lines of fire which intersect each other; the second contains the magnitudes of the ordinates representing the distances of the points of cross-fire, from the principal axis X Y; and the third, the distances of the ordinates estimated on the principal axis, from the common point of origin K. To refer for example, the point of intersection produced by the lines of cross-fire B *b* and C *c* to the axis X Y, it will be found, that the ordinate *n* G = 18. 2 feet, and the ordinate G K = 6. 2 feet. So also, for the point of intersection of B *b* and L *l*, we have the ordinate *l* L = 19. 5 feet, and L K = 8. 0 feet.

Lines of fire producing different intersections.	Magnitudes of the ordinates, representing the distances of the points of cross-fire from the principal axis XY.	Magnitudes of the ordinates, estimated on the principal axis XY, from the common origin K, to the points where the preceding ordinates intersect the same.
Intersection of B*b* with C*c*.	*n*G = 18·2 feet	GK = 6·2 feet
Intersection of B*b* with L*l*	*l*L = 19·5	LK = 8·0
Intersection of B*b* with H*h*, & with E*e*	*y*Q = 59·5	QK = 61·3
Intersection of C*c* with K*k*	*k*K = 47·3	K = 0·0
Intersection of D*d* with E*e*	*d*N = 15·2	NK = 22·0
Intersection of D*d* with F*f*	*x*R = 32·0	RK = 76.8
Intersection of E*e* with I*i*	*i*O = 19·0	OK = 25·4
Intersection of *f*F with *f*F	F = 0.0	FK = 20·0
Intersection of F*f* with M*m*	*m*P = 4·5	PK = 27·8

The danger of fire, from the explosions of the guns taking place *within board,* has been briefly alluded to; but as the superiority of the curvilineal stern, in this point of view, is strikingly conspicuous, it may not be improper to allude to this part of the subject more particularly.

By comparing Figs. 4 and 5, Plate IV., it will be perceived that, in the old form, (Fig. 4,) the muzzle is twenty-one inches *within* the rail; whereas, in the new form, (Fig. 5,) the muzzle is eighteen inches *beyond* the frame of the stern;—the guns in each being supposed in a fore-and-aft direction. It is scarcely necessary to insist on the superiority of the latter form above the former, in relation to this very important consideration; since an explosion can never take place *within board,* without obvious disadvantages and danger. When the guns are trained, the evil will be increased in the square stern:—whereas, with the greatest possible angle the case will admit, in the curvilineal stern, the muzzle is never *within* the stern-frame. These disadvantages in the square stern, arise from the overhanging form of that part of the ship, and from the inconvenient distribution of the timbers of the frame*.

With respect to the guns at the after-broadside ports of the two frigates, it may be observed, that they are under precisely the *same* circumstances, their muzzles in both cases being *beyond* the

* The form of the square stern being borrowed from a remote antiquity, and before the employment of artillery on shipboard, necessarily brought with it numerous disadvantages. Had the stern been adapted to the guns, instead of the guns to the stern, there can be no doubt but its primitive form would have been assimilated to a curvilineal line. Nor, in this case, would it have presented so massy and cumbrous a figure, or have been so overloaded with barbarous specimens of sculpture, as disfigured our ships of war, even of a modern date. When we refer to the sterns of the Great Harry, or of the Royal Prince, we can scarcely conceive that the essential and proper objects of a ship of war were contemplated by their constructors. In tracing also the history of naval architecture, since the introduction of artillery, we may clearly perceive the steps by which, in successive periods, the old stern has been shorn of its ornaments, and pruned down to a form more consistent with the purposes for which a ship of war is intended. It required, however, another and a greater step to transform it into the curvilineal stern.

side of the ship, and also in the same degree. A fore-and-aft view is given in Fig. 6.

With the quarter-gun of the new form, no comparison can be made with the square stern; but by a reference to Fig. 7, which represents a view of the quarter-port of the Hamadryad, the projection being square from the side of the ship, and the gun run out as far as possible, it will be perceived that it possesses all the advantages of a broadside-port, the only difference being a rather less projection of the muzzle, in consequence of the quarter being nearly perpendicular, and not falling in, as is the case at the broadside. Any explosion must therefore pass clear of the side of the vessel, with nearly the same security as if the gun were placed at a broadside-port.

Among the objections that have been urged against the adoption of the curvilineal stern, is the apparently-formidable one, that a broadside-port has been lost on each side of every ship to which it has been applied. After a careful examination, however, of this objection, with respect to the Hamadryad, I feel no hesitation in stating, that so far from this being the case, it will not be extravagant to assert, that one has actually been gained on each side by means of the quarter-port.

To demonstrate this, let a reference be made to the line of fire L*l*, Fig. 2, Plate III., and by which it will appear, that the quarter-port may be readily and satisfactorily employed as a broadside-port:—for since it was found possible, by the naval gentlemen who assisted in the experiments, to train the gun at the quarter-port into the direction C*c*, forming an angle of 12° *before* the beam, with much greater ease would it be possible to work it in the line of bearing L*l*, *on* the beam. This circumstance adds therefore, to the ordinary and essential uses of the quarter-port, the additional advantage of being effectually employed, when occasion requires, in aiding the defence of the broadside.

Nor should it at any time be forgotten, that the facility with which *all* the guns can be worked in the curvilinear stern, for the different points of bearing before described, and the total absence of all the timbers and other obstacles which, in the square stern, occasion

so many serious and decided impediments, increases in a very high degree the advantages likely to result from the general application of the new form. To take the example of a man of war becalmed in the Bay of Gibraltar, or at the entrance of the Baltic,—situations in which our gallant seamen have sometimes been exposed to the irritating and destructive effects of raking fires from gun-boats,—is it not apparent, from the preceding experiments, that a ship with a curvilineal stern, so circumstanced, would be enabled effectually to resist any attack of this kind *. And that even if the vessel so acting on the offensive should vary her position with the facility that a steam-boat is capable of imparting, could not the guns at the quarter and stern-ports be as readily made to follow her? Nor would it be possible for the attacking vessel to take up any position in the neighbourhood of the stern, without having a gun or guns ready to resist her. This is an advantage which ships constructed on the old principle never possessed; and I have been assured by a gallant Admiral, who for a considerable time held a command in the Baltic, that the ships of his squadron, when convoying merchantmen through the Belt, have frequently been obliged to heave out warps, in order to bring them round to get a gun to bear. Sometimes, indeed, when from the facility with which the gun-boats could be moved from one situation to another by means of their sweeps, the warping of a ship would prove ineffectual, it was found necessary to form the armed boats of the squadron into a line of defence for the merchantmen. These are difficulties which may again occur, and for which, in a time of tranquillity and peace, and when the merits of every plan can be rigorously and impartially examined, we ought to prepare. The same distinguished officer has more than once assured me, that if the call of his country should again place him in the Baltic, he would most unquestionably apply to the Admiralty for round-stern ships.

It is not, however, to be supposed, in a profession where a

* Since this was written, the Revenge of 74 guns has afforded, before Algiers, a very satisfactory example of the great advantages to be derived from the curvilineal stern, in resisting an attack from gun-boats.

devotedness to the national honour and glory forms so decided and pre-eminent a characteristic, that during the varied and trying services of a war like the last, no one conceived the square stern to be imperfect, or that advantages would not result from its alteration. We have, in the first place, the case of the Prince, in 1798, to prove that more than one of the officers entertained the idea that a change of form would be advantageous. Thus, Lieutenant, now Captain Crawford, remarks, that "many here complain of the want of strength in the construction of our ships' sterns, and also of their *improper form for defence;* for instance, we cannot fire a gun from our lower deck out at the stern-ports, without materially injuring the lower counter, it is so flat, and overhangs so much;—from the middle deck we cannot fire without cutting away a transom that is placed so high that the guns cannot be pointed over it." And with the same conviction of the improper form of the stern, Captain Larcom, who commanded the Prince at the same time, gave it as his opinion, "that the stern of a man of war should be constructed like that of a Dutch fly-boat; that *there should be ports all round,* to enable you to fire in every direction, and from all the decks."

The alteration, however, which in the case of Captain Larcom was only advanced as an opinion, in that of the captain of the Phœnix frigate was actually carried into practice;—at least as far as the very imperfect form of her square stern would admit. In the account of the action of this frigate with the Didon, her gallant commander observes, "I believe it has long been understood that the quarters of ships are worse defended than any other part of them; and as this idea struck me forcibly whilst in command of the Phœnix, *I ventured to make an alteration,* to which I attribute a good deal of the success obtained over the Didon. *It was the clearing away the timber-heads in the way of the windows* NEXT THE QUARTERS, in the same manner as most of the frigates had done with those next the rudder-head, thereby *obtaining a port which acted almost in a bow and quarter direction.* The effect of our first fire from that gun (quarter-gun) was such as almost to insure the success of the battle. I was told," continues

the gallant officer, "that twenty-four men fell from the first discharge." The fact alluded to, also, of most of the frigates having cleared away the timbers next the rudder, plainly proves that the old arangement of the stern was not considered as advantageous by a considerable number of officers.

There is one other objection that has been urged against the adoption of the curvilineal stern, and which I would briefly advert to before concluding this paper, and that is, *that British ships were never intended to turn their sterns to the enemy; and that our sailors ought not to be taught the possibility of running away.*

If British seamen were really so low in the scale of moral and physical energy, and their love of country and national glory so feeble and languid, that mere *alteration of form* could diminish their enterprise and spirit, and weaken the noble devotedness which, under *all circumstances*, they have hitherto so enthusiastically displayed, the objection might be supposed to have some weight;—but when we know, on the contrary, from the most ample and glorious experience, that no situation or condition, no time or place, is capable of altering or impairing, in the smallest degree, the essential and well-established elements of their character, I cannot consider the objection in any other point of view, than as a severe and an unjust reflection on a brave, a loyal, and a devoted race of men. With equal propriety might it have been urged, at the time that the musket was first introduced, that the personal bravery of a Briton would be impaired, because by the weapon then placed in his hands, he would be enabled to destroy his enemy at a distance, without the necessity of engaging in close combat. Yet we find that, although the musket in its simple state was employed for a very considerable time, when the progress of military improvement eventually added to it the bayonet, no want of resolution was displayed in its application; and, up to the present hour, no one can assert that the personal courage of our brave soldiers is in the smallest degree inferior to what it was when close combat formed the distinguishing characteristic of war. And in a race of men like our sailors, whose highest glory it is to conquer difficulties and obstacles of *every kind*, it is most unjust and most

absurd to suppose that the habits of conquest, which for ages they have been accustomed to cherish and confirm, are all at once, or even at any time, to be transformed into timidity and fear, because the light that has been latterly thrown on naval architecture has demonstrated that the frames of our ships can be strengthened, and better means of defence be obtained, by the new form of the stern. There can be no doubt but a British seaman will always fight the battles of his country to the last extremity, whether he be placed on the unprotected surface of a raft, or in a vessel of any class, let her form and condition be what it may. It is enough for a British sailor to know, that ENGLAND EXPECTS HIM TO DO HIS DUTY, and it will be done.

In a subject of so very practical a nature as the present, *facts* are of the utmost importance; and as, in the investigation of natural phenomena, the philosopher seeks for legitimate examples to illustrate his subject, so do the advocates of the curvilineal stern most earnestly court inquiry and discussion. In the present paper I am not aware of having advanced a single remark, but what has been fairly deduced from the experiments performed. It was an advantage also, during the prosecution of the experiments, that the naval officers present entertained dissimilar opinions; some of them being advocates for the new form of the stern, and others for the old; and which diversity of opinion afforded me an opportunity of hearing a multitude of valuable practical remarks, which could never have been elicited had they all entertained the same views.

In concluding the present paper, I cannot refrain from expressing my decided conviction, that the adoption of the curvilineal stern not only increases in a very considerable degree the means of defence in every ship to which it is applied, but also adds very much to the mechanical strength of her frame; and that it would be folly to abandon a form which has so many legitimate claims on our attention, from any undue and improper attachment to one which has unquestionably nothing to recommend it, but custom and time. In the changes that are daily taking place around us, from the new and ever varying improvements in the mechanical arts,

and to which our country, at the present time, owes so much of her welfare, prosperity, and power, we may draw innumerable maxims to prove the impropriety of chaining ourselves to systems which have nothing but the authority of time to recommend them, and from which science withdraws her countenance and support. The present indeed is an age of brilliant and unbounded improvement; and every day brings us new accessions of knowledge and new triumphs of genius over the obstacles of nature; and therefore naval architecture, which is but just emerging from the slumber of ages, and from the trammels of imperfect and antiquated rules, ought by no means to be checked in its career. The present time, also, is one peculiarly auspicious for an inquiry of this kind. Peace and tranquillity extend every where; and we have just that degree of naval activity, that will enable us silently, but effectually, to carry into our marine every improvement that the enlarged experience and science of modern times can afford,—to increase to the utmost the mechanical strength and the means of defence of our floating bulwarks, and likewise the means of navigating them securely across the uncertain bosom of the deep.

Plymouth, July 1, 1824.

Art. II. *On the Motion of the Heart. By* James Alderson, Esq., B.A., Fellow *of* Pembroke College, Cambridge, *and of the* Cambridge Philosophical Society.

[Communicated by the Author.]

In our researches into the phenomena of nature, it is absolutely necessary that we not only distinguish theory from mere hypothesis, but that we do not rest our inquiries on any thing short of absolute demonstration; and although "jurare in verba magistri" may be admitted in so clear a case as the circulation of the blood, discovered and demonstrated by the immortal Harvey, yet we are by no means justified in giving the same degree of consequence to the opinions of the Hunters on the heart's motion, though their

opinions have been copied, and assented to by every* succeeding physiologist.

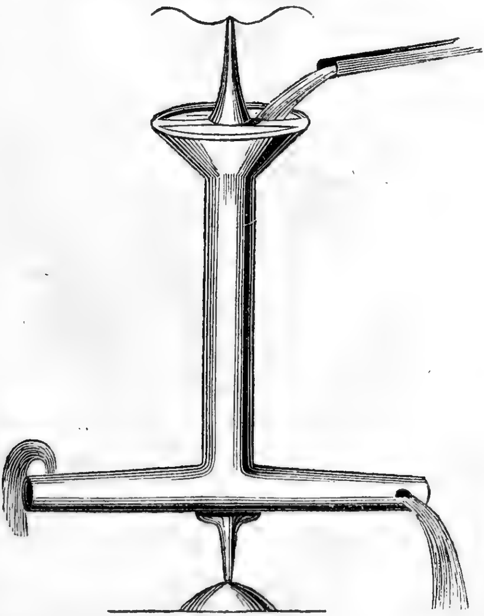
The object of the following remarks, is to shew that their hypothesis is not founded on demonstration, nor on sound philosophical principles; and that it must not be handed down in the same page with that of Harvey.

We find in a note in John Hunter's *Treatise on the Blood,* a reason given why the apex of the heart strikes against the chest in its actions, *viz.,* "that the heart throwing the blood into a curved tube, *viz.* the aorta, that artery at its curve endeavours to throw itself into a straight line to increase its capacity; but the aorta being the fixed point against the back, and the heart in some degree loose or pendulous, the influence of its own action is thrown upon itself, and it is tilted forward against the inside of the chest." We are further told in the same note, that "*the systole and diastole of the heart simply could not produce such an effect,* nor could it have been produced, had it thrown the blood into a straight tube in the direction of the axis of the left ventricle, as in the case with the ventricles of fish, and some other classes of animals." Now this last remark, as far as it relates to the hearts of fish is undoubtedly true, but it leads to a question which shakes the validity of the former opinion, relative to the motion of the human heart, *viz.,* supposing the aorta in fish to be curved, as the human aorta, the direction of the aortic orifice *being still* in the *axis of the ventricle,* would the motion of the fish's heart be similar to that of the human heart? It certainly would not; for whatever re-action might arise from the action of the curve of the artery, this re-action must take place *in the direction* of the *axis,* and hence the discharge of the blood from the ventricle could only tend to lengthen the ventricle in the direction of the axis. Besides, this action, supposing it the effect of the arch of the aorta, must consequently take place after the blood has been expelled from the ventricle by the

* Barclay on *Muscular Motions of Human Body,* p. 567; Richerand's *Elements of Physiology,* p. 168; Mason Good, *Study of Medicine,* vol. iii. p. 406; Blumenbach, *Institutes of Physiology,* Note A, by Dr. Elliotson, p. 66; Bostock, *Elements of Physiology,* p. 346.

contraction of its parietes. Now we need scarcely seek the authority of Laennec*, to convince us that the impulse of the heart *is only felt* at the *moment of the systole of the ventricles*, and hence the heart must have already commenced its motion towards the parietes of the chest, previously to the blood's arriving at the arch of the aorta. The heart's motion must therefore depend on other causes than the *efforts* of this great vessel †.

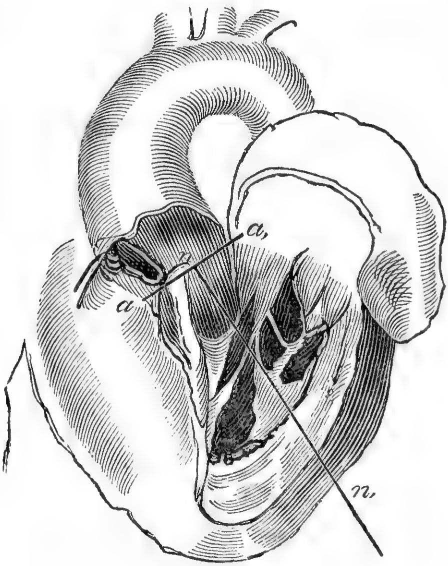
As the language of the schools is not familiar to all, and as we sometimes find that an appeal to some effect that is tangible often renders, or appears to render, a fact more clear and more easy to be understood, than the strictest mathematical reasoning, I may be excused annexing a sketch of that beautiful and well known invention of Mr. Barker, called Barker's Mill.



* *L'Auscultation Médiate*, p. 207, v. ii.

† It is clear from the following passage, that Laennec was aware of the fact

It consists of a vertical cylinder, supported by a spindle, allowing of a rotatory motion. This cylinder is met by another, which is horizontal, and in which, near its extremities, and on opposite sides, are cut two orifices, from these orifices the fluid supplied from a spout is suffered to escape. The effect produced, is a rotatory motion, *arising not* from the resistance given to the issuing fluid by the air (for it would have place in vacuo), but from the want of resistance to counteract the pressure of the fluid against the sides of the horizontal cylinder *opposite the orifices,* and this is the principle I purpose making use of to account for the motion of the heart.



of the isochronism of the beat with the contraction of the ventricles, though he has no where accounted for it. "Au moment où l'artère vient frapper le doigt, l'oreille est légèrement soulevée par un mouvement du cœur isochrone à celui de l'artère et accompagné d'un bruit un peu sourd quoique distinct. L'isochronisme ne permet pas de méconnaitre que le phenomène est dû à la contraction des ventricules."—*De l'Auscultation Médiate,* vol. ii. p. 216.

Let us suppose the annexed figure to represent* the *left* ventricle *a a*, the aortic orifice *n n*, a normal to that orifice. Now when the ventricles are filled just prior to their contraction, (the auricles of course being empty) the aortic orifice will at this time be situated posteriorly, and to the right side of the ventricle, and hence the normal *n n*, from the centre of the orifice, will intersect the parietes in a point (*n*,) situated anteriorly, and to the left side of the ventricle. Hence a vertical plane passing through (*n n*), (the body lying horizontally, and the heart in its natural place) will *nearly* be in the direction of the heart's motion.

Let us further suppose the aortic orifice *a a* to be closed by a plug, retained in its place by the finger, and that the ventricle be now allowed to contract; it is clear, that it will require a certain force to keep the plug in its place, *i. e.* to counteract the effect of the re-action of the blood arising from the contraction which takes place in a similar † portion of the parietes on the opposite side of the ventricle in a contrary direction.

If then, we remove the finger, and allow the blood to escape, the re-action on the opposite side of the ventricle remains uncounteracted; and it is by this uncounteracted force that the heart is moved.

That the arch of the aorta may *modify* the heart's motion, I will not deny, but that the heart would have this motion independently of the aorta altogether, so long as the aortic orifice be out of the axis of the ventricle, is most certainly true.

I am aware that mechanical physiologists are in no great repute at present, and probably no organ has contributed more to produce this opinion than the heart itself; still it must be admitted, that ‡

* The whole effect produced does not arise from the action of the left ventricle alone, nor will the heart's motion be in the direction *nn*, but in that of the resultant of the two forces produced by the contraction of the left and right ventricle conjointly; for our purpose, the consideration of the left ventricle will be sufficient.

† We here suppose, for sake of convenience, that each portion of the parietes of the ventricle contracts with an equal force.

‡ Bostock, *Elementary Treatise on Physiology*, vol. i. p. 416.

"with respect to mathematical reasoning in general, when it is cautiously applied, it has enabled us to arrive at physiological truths, which we perhaps could not have attained by any other method, and which are beyond the reach of actual observation."

Art. III. *Notes on the Geography and Geology of Lake Superior. By* John J. Bigsby, M.D., F.L.S., *and* M.G.S.

[Concluded from p. 34.]

I have now to describe with some minuteness, the nature, contents, and connexion of the rocks above enumerated, as they occur in succession on the north shore; and commencing from Gros Cap. This concluded, I shall give a rapid view of the principal points in the geology of the south shore.

The south headland consists of a very compact, brick-red porphyry, which extends a mile northward in broken scarps, and in perpendicularly fissured cliffs. It is the same as certain varieties of the porphyries of the Pay Plat, excepting that it is not quite so slaty, and that the colour is paler. Its paste is homogeneous and fine grained ; the fracture, obtained with difficulty from its facility of division along the natural cleavages, is imperfectly conchoidal, passing into uneven ; the lustre is dull,—in hardness, it scarcely yields to the knife. The odour of clay is very strong on being moistened. It contains numerous small irregular masses of limpid quartz and small crystals of pale-red feldspar. There are druses of pyramidal and rhomboidal calcspar ; and also epidote, in fissures, and in druses of capillary crystals. It is full of confused rents, large and smooth, but I could perceive no stratification.

This porphyry is replaced suddenly, without any change in the aspect of the hills for a second mile, by greenstone, blackish blue, fine granular, and small crystalline, with occasional small crystals of red feldspar, according to the specimens I took from the isle 1000 yards north of the porphyry. I there observed, as I thought, traces of stratification, for three or four yards in parallel

layers two feet thick; the direction being N.W. and the dip N.E. Similar appearances exist near this on the main; but every where else the rock is massive, or full of confused cross-rents. For the remaining two miles there is an apparent alternation of greenstone and granite (perhaps sienite), the dimensions of each bed being as follows:—A red granite, extending along-shore 750 yards, is followed for 1000 yards by an intimate commixture, in tortuous veins and masses of all sizes, of pale greenstone and red granite, the union being most perfect at the south end. This is succeeded for 750 yards by light red granite, three times interleaved in the space of 350 yards by masses of greenstone, each, at a rough guess, 50 yards broad. Their sides did not appear to be parallel. Their only being visible lengthwise for a few yards leaves me in doubt whether they be strata, veins, or imbedded masses. In the next and last 1000 yards, the rocks are red granite with epidote, more or less veined and mixed with greenstone, either largely in seams, or as in the Rock of Le Serpent in Lake Huron, or more minutely still. I have had no opportunity of ascertaining correctly the ingredients of the rock I here call granite. They are all unstratified, except where that structure has been adverted to above.

The very short beaches under Gros Cap, and the larger of Batchewin Bay, are plentifully lined with bowlders of white sandstone, amygdaloids, greenstone, the Gros Cap porphyry, and a greenstone porphyry, abounding chiefly in Lake Huron. To these are to be added the greenstone puddingstone of Pelletan's Channel, (L. H.) the jasper puddingstone of the foot of Lake George, and various quartzes, granites, and gneiss.

The Falls of St. Mary, (and that river generally, it may be concluded,) Batchewine Bay, the Maple Islands, Green Island, and the two bays south-east of Point Marmoaze, are based on sandstone; in an horizontal position, universally, on the east and north shores, except near the north headland of Gros Cap, where, for a short distance along the margin of the water, it inclines from the hills; by displacement, not conformably to the elder rocks, for here they seem to be massive. This sandstone has been shewn to be of vast extent in Lake Superior. It is

visible near Michilimackinac in Lake Huron, although only in numerous angular fragments: it overlies transition rocks in that lake, at La Cloche, 120 miles east from the Falls of St. Mary, and is, probably, contemporaneous with the sandstone of Niagara and Genesee. It is composed chiefly of grains of quartz, white or coloured, usually fine; small fragments of flesh-red feldspar are often present and sometimes abundant; and a few spangles of mica. It is without cement, or there is a sparing quantity of argillaceous or ferruginous matter. Mr. Schoolcraft reports two examples on the south shore, of the presence of lime; the sandstone of the Mammelles and Nipigon Bay often effervesce also on application of acids. It does not cohere very strongly, but in many cases, as at the rapids of the Nibish (Lake George), it is very hard, and imperfectly crystalline. Commonly it is divided into thin layers; but on the east shore of Batchewine Bay it is in masses five feet thick. Its colours are red, brown, white, and yellow, single tints prevailing throughout a precipice, or alternating in layers, or again, several staining the same layer in clouds, spots, and rings. Solitary colours, as brown and white, are common in the north, while the variegated form is most abundant in Batchewine and the River St. Mary.

I was so fortunate as to be twice ashore at the junction of this sandstone with the amygdaloid of the Marmoaze, which is exposed to view at the west angle of the Bay south-east of that point. It is here greatly altered in constituents and in position. It is a particoloured work, massive and schistose in portions, soft, coarse granular, and likewise, in patches, consisting of large fragments of its own substance. It is non-effervescent in acids, except where calcspar happens to be present, which it now and then contains, together with numerous spots and masses of green earth, sometimes so plentiful as to colour the rock. It suffers much from weather. When slaty it is red, yellow, and white, in layers; when massive its colours are in clouds, green then being often prevalent. This rock is highly inclined in various ways. At the east end of the Cape*, it runs conformably to the trap adjacent,

* These Capes are never literal points

that is, north, from the lake into the woods, in ridges 10 and 15 feet broad, separated from each other by beach; but a few yards westward of this, they suddenly turn north-east, and then by a sharp but unbroken bend they pass to the north-north-west, maintaining that direction for a considerable breadth, with waved contortions, curving backwards upon themselves, as singular as those occasionally in gneiss. Near this remarkable change of direction, nodules of this sandstone are imbedded in the general mass; and there is some indistinctness of stratification. This rock is seen here for 400 yards, and is lost on the south-east in shingle and sand, on the south and west in the lake, so that its transition into the common form on the south side of this bay, *&c.* cannot be witnessed. On the north-north-west it comes in contact with amygdaloid; the junction, however, being completely obscured by a fissure three or four yards broad, full of rubbish. The sandstone near this spot is quite a breccia of its own fragments, each from $\frac{3}{4}$ lb. to 3 lb. in weight.

The amygdaloid extends rather more than seven miles north-westward, and about three miles beyond Point Marmoaze. The base of this rock is hornblende;—in fact, it is truly a greenstone at $2\frac{1}{2}$ miles and at 4 miles below this point, with a very few small nodules of calcspar coated with green earth, or flattened agates On the main and isles adjacent to Point Marmoaze, much of the rock contains merely green earth finely disseminated. But by far more commonly, it is quite full of almond, bean, or pea shaped masses, sometimes ramose, and usually small. They are composed of white calcspar and red zeolite*, associated or apart, the latter being the rarer. These masses are both distinct and confluent, and as they weather readily, they leave the crust of the rock quite vescicular for some depth; as much so as lava. When foreign substances are not numerous, the rock, in disintegrating, separates into roundish polyhedral concretions, which finally resolve into argillaceous earth. The colours of the sound rock are brownish, greenish, or reddish black; these changes taking

* Other substances will be mentioned in the sequel.

place by insensible shades in the same stratum. It now and then becomes red suddenly for a few square feet, from the presence of iron: then the accidental minerals are few, and of obscure characters.

This trap at first sight appears unstratified, lining the shore in rugged shelves from 10 to 100 feet high, separated at intervals by sand and shingle beaches, and rising out of the lake in low islands, narrow oblong rocks, and in reefs. It is, however, in distinct strata, usually somewhat massive, but often more or less shaly. They almost all go north-north-west, but some, north and north-north-east. They are at least 50 yards broad; but the breadth is not easily ascertained, from their condition as to weathering, and from the frequent indentures of this tempestous coast only exhibiting small patches of the rock, which are immediately lost in the woods, beaches, or in the lake. They incline westward with a rough, lumpy, surface, often hollowed by the waves into bowls, caves, and small arches. The strata visible for the greatest distance are 2½ miles below Point Marmoaze *. One of them is 400 yards long.

In the bay, of which Point Marmoaze is the south-east angle, at that point, and for a short distance below, a dark brown puddingstone is conformably interleaved at irregular intervals. Its strata, dipping at an angle of 40°, are equal in size to the amygdaloid. Near Point Marmoaze, the end of one of these strata is broken into cubic fragments, 8 and 12 feet square, heaped upon each other in a high confused pile. In most instances, this puddingstone is not seen in contact with another rock, but a mile and a half below Point Marmoaze, it is supported on a hard, pale greenish amygdaloid, full of flat masses of green earth, and nodules of quartz, and brown and blue agate. The line of division is abrupt and well marked; but there is now and then interposed, a fine (coarse in places) reddish-brown sandstone, from 9 to 12 inches thick, studded with two or three rows of pebbles parallel with the stratification: the sandstone close to them being glossy and

* I was three days near this Point.

compact. This great stratum of conglomerate has no subdivisions, but has frequently a partial layer, (one foot thick, with ragged, thinned, edges) a few yards square only, of this sandstone, coarse, or very fine, and even resembling baked clay. This conglomerate is cemented by the finer fragments of the rocks forming the nodules, often so small as only to be discerned by careful examination. The nodules are rounded and lie promiscuously, usually set very fast, the outer ones not loosening readily on exposure to the air. The largest are 30 lb. in weight, the smallest are invisible; the average weight being from a quarter of a pound to a pound and an half; I saw one, however, which might weigh 100 lbs. They consist of various greenstones, pale granular, and red porphyritic granites, numerous translucent white, and brown granular, quartzes, the former having a bright red tint around the outside only. The majority of these nodules, however, are the different species of amygdaloids and dense ferruginous sandstones. Masses of green earth are not uncommon. Most of them have a thin envelope of this substance, of calcspar, or of iron-rust, sometimes indeed of all the three. White rhombic calcspar occurs in this pudding-stone in nests and veins from one to four inches thick, traversing it in all directions. In two instances I saw a vein of calcspar, a quarter of an inch thick, pass successively through a nodule of greenstone, granular quartz, and an amygdaloid.

Three miles or more below Point Marmoaze, the waves have laid bare two patches of conglomerate, conformable to the trap, but rather resembling the sandstone of Batchewine than the puddingstone of Point Marmoaze. The one is slaty, dark brown, and of fine texture, nodules obscure; the other is very coarse, and consists of fine sandstone nodules, red and white, with masses of green earth, calcspar, *&c.*

The veins in the amygdaloid are numerous. They are as follows:—A dense clay iron-stone ½—1 inch thick, vertical, running in all directions, and ramifying at acute angles. 2. Satin spar, white, (having rarely a tinge of red,) in veins from a quarter of an inch to an inch thick; vertical, running obliquely to the stratification, several veins in company, nearly parallel, and sending off

rectangular branches. These veins consist of two tables, separated by a rift in the middle, and each bending round, without fracture into the ramification. The fibres composing these tables are perpendicular to the axis of the vein; seldom oblique. 3. Veins of white rhombic calcspar are not unfrequent, with facets, an inch or more in diameter, passing across the strata, and often parallel to them for long distances. They are from two to six inches wide, but often expand in a lenticular form, and then sometimes contain a small mass of the amygdaloid in which they are placed. They are most common near the conglomerate at Point Marmoaze. On the outer woody isle off this point, there is a vein of this mineral invested and penetrated by large masses of green earth. 4. Veins of quartz in two adhering parallel tables are occasional, which here and there open, and exhibit druses of quartz crystals, seldom of amethyst. 5. A vein of amygdaloid, three inches broad, with well defined and nearly parallel sides, of the same kind as that supporting the conglomerate of Point Marmoaze, crosses a ridge of amygdaloid a few hundred yards from that conglomerate. It is about five feet above water-mark; and is of a dark colour, and very full of almonds of calcspar, frequently coated with zeolite.

The imbedded substances of this amygdaloid are various and plentiful. They are calcedony, bluish white; calcspar, red, white, and green; zeolite; stilbite; prehnite; rock crystal; amethyst; agate, striped and fortification carnelian, green earth; copper pyrites; green carbonate of copper and plumbago. The greater part of these are usually coated with green earth. The four first, and green earth, are sometimes in such quantities as to constitute the greater part of the stratum. There is a black amygdaloid three miles below Point Marmoaze, full of small vesicular druses lined with very brilliant rock crystals and botryoidal calcedony. In such druses the prehnite occurs, in mammillary coatings. Calcedony and zeolite are most abundant two miles below Point Marmoaze: agates and carnelian (amber-yellow and pale red,) a mile and an half lower down. I there saw the remains of two splendid groups of quartz crystals, 10 inches in diameter. Red zeolite often forms, hereabouts, small naked and solitary deposits

in bundles of fibres—usually both it and the stilbite (red and obscurely crystallized) are imbedded in, or superimposed on calcspar. Here the green earth becomes compact, of conchoidal fracture and disseminated in fine grained dark amygdaloid, which in other parts of the same ridge becomes paler, and contains the ordinary agates and calcspars. The beaches of this district have many small bowlders of shell limestone, probably of the same age with that of Derbyshire, of amygdaloids with copper pyrites and the green carbonate of that metal. I saw among them one mass of radiated quartz. It is a geode:—on breaking it the fractured surface presented three centres, from which imperfect crystals diverged in a stellular form.

The trap of the Marmoaze, whose situation and nature have now been sketched with all the fidelity my opportunities would allow, is succeeded by white granite. A ravine at the centre of the bay next on the north separates these two rocks; the latter being a high escarpment, while the former, throughout the south side of the bay, is in low ledges separated by sandy beaches. This granite now occupies the north shore for 58 miles of the canoe route. Huggewong Bay is an example of the style of country it produces. It is white, or nearly so, the feldspar being white or pale red, and predominating; the quartz white, and the mica scanty and in small black plates. As well as I recollect, there always is a little hornblende disseminated, and commonly a large quantity. Much of this granite is of moderately-fine grain; but now and then it is slightly porphyritic. It contains very numerous contemporaneous masses of a very large porphyritic kind, from one to fifty yards in diameter, sending off trunks which ramify in all directions, and frequently unite with others of these masses; and as frequently are lost in the imbedding rock. This form of granite consists almost exclusively of feldspar and quartz, both white, the crystals of the former being from six to eight inches in diameter. By the gradual diminution, in many cases, of these crystals, and of the fragments of quartz, towards the outside of these knots and branches, a slow transition is effected into the granular granite. Both these species are traversed indifferently by

considerable veins of white quartz. This mixed form of granite exists all over this district; but is particularly distinct at the Cape 7 miles north of Point Marmoaze, about Point Huggewong, and at the first headland, north of Gargantua. The granular granite, not at all, or but little, mixed with the porphyritic, obtains in large quantities, forming some of the heights of Huggewong Bay, and the bluffs of the shores north of that bay, one of whose hills I ascended, and found to be composed of this kind at all levels. But a great part of this granite, besides containing hornblende disseminated promiscuously, is associated with this mineral in three additional modes—intermixed confusedly, and covering both large and small spaces. It receives from the hornblende a lamellar structure, by alternating with it in very thin plates more or less continuously, the direction (with contortions and wavings,) being usually E.N.E., the dip either perpendicular, or N.N.W. at an high angle, as about Montreal and Gravel Rivers, and at the south angle of the bottom of Huggewong Bay. Near Gravel River the direction is also EbN. and E. dipping northerly, and close by this spot, for several acres, an apparent displacement gives a N.N.E. direction, bounded, on both sides, by the same rocks, passing E.N.E. and N.E. The N.N.E. direction of these laminæ exists also at a principal bluff a few miles south from the Montreal River, with great confusion in the contiguous layers. Hornblende occurs too, in irregular-imbedded masses, from two to twenty-five yards square, traversed by few or by many veins of granite from one to ten feet thick, in the most fantastic manner imaginable. These are very abundant. They are seen as bowlders on the portage at the Falls of St. Mary. The hornblende in these cases is sometimes pure, though rarely, it being almost always intimately and plentifully mixed with grains of white quartz so disposed as to impart a slightly lamellar structure. The third form in which hornblende appears in this granite is, what may be interleaved, beds of greenstone, varying in thickness from a few feet to an hundred yards. It is most common on the south skirts of Huggewong Bay, and from Huggewong Point to Gravel River. This greenstone never shews any tendency to slatiness, and is fine

granular or slightly crystalline. Its colour varies from very dark green to black and brownish black; when of the two last colours it often assumes a bright jet glaze. Although quite a trap in its mineralogical characters, its cross fissures are not particularly marked, and never divide into columns as near the crags of Michipicoton, *&c.*, except once in the hill of reddish gneis-like granite, near Gravel River. Four miles and a half south-east from that river the greenstone is rendered sienitic by the developement of its feldspar in large red grains. It every where contains calcspar. I could not ascertain precisely whether these amphibolic masses are stratified, as they are only exposed in the narrow margin between the lake and the woods. They are frequently seen in contact with the granite in a well defined and slightly-serrated line; neither rock being altered in constitution or appearance.

This granite passes in the rear of Point Gargantua: and is replaced by greenstone on the south side of the bay contained on the north by Cape Choyyè.

Point Gargantua and its neighbourhood are formed of amygdaloid, whose connexion with the contiguous rocks, as presented to me in passing by them rapidly though closely, seem to demand considerable attention. This amygdaloid is nearly the same as that of the Marmoaze, and has the same geological characters, its ridges having the same dimensions, aspect, direction, and inclination; and the same veins and mineral contents. The zeolite is finer here. It is imbedded in large masses of calcspar and quartz in groups of fibres radiating from a centre, and losing themselves insensibly at the circumference of the circle they create, in calcspar. I landed at three places, and at all found the same rock, modified, however, by the prevalence, or want, of particular foreign minerals. Ferruginous matter prevails a good deal. I met with only one conformable seam of conglomerate, about eight feet thick, near the water's edge on the outer island. Its nodules are chiefly ferruginous sandstone, thickly coated with calcspar, and some stilbite; I perceived a fine carnelian among them. The glossy substance resembling a baked clay, noticed at Marmoaze, is interspersed in this puddingstone,

in thin slips. The southern islet of this small group is a cliff, apparently of the sandstone changed and disturbed, near Marmoaze, but as I could not land, I cannot say positively. The shores of the main a few miles south abound in debris of sandstone. The main opposite to this isle I believe to be granite. Landing rather more than a league to the south of this I found in the laminar form of the granite, above described, an imbedded or interleaved mass, several hundred yards broad along shore, of a shaly brick-red rock, extremely ferruginous, containing green earth, calcspar, and green and purple fluor (the fluor was detected by Major Delafield). This rock is greatly weathered, the surface scaling off in thin plates; and abounding in empty vesicular cavities, and bowls formed by the waves, as is common in the amygdaloids of Lake Superior. It appears to me to be a decomposing trap, almost a ferruginous clay. At its well marked contact with the gneis-like granite neither rock is altered. The latter passes E.N.E. and N.E., dipping S.S.E. at angles of 70°. and 45°. Certain fissures in the red rock incline me to believe it to be conformable.

At its north end the amygdaloid of Gargantua seems to pass into granite—a fact for which I was not prepared, and in which I may be mistaken. The steps in this transition are these (as they appeared to me) :—It first loses its almonds; and is then a trap, simply, for a few hundred yards, but not in the extremely crumbling state usual to amygdaloid. Then feldspar, mixed with quartz is added, the mass assuming the shape of thick leaves going east and west, and having veins one foot thick of a red jaspery matter. Finally, at the point next to Gargantua on the north the rock is the perfectly compound granite of Huggewong.

The greenstone alluded to, as first touching upon the lake near the bottom of the south side of the bay of which Cape Choyyè is the north headland, overspreads the whole of Michipicoton Bay and crags, except a small space west of Point Perquaquia. Its actual junction with the granite on the south has not been visited. This greenstone is fine granular and compact; both massive and slaty in the large, at intervals, by gradual passage.

It is black, light brown, shining gray, pale and dark green, and even dark red, from the presence of iron. The gray colour arises, probably, from an abundance of quartz, as that mineral, white and crystalline, is plentiful in veins and imbedded masses. The green is derived from chlorite, as we learn, from the tint and from its frequency about the Peek and elsewhere. This greenstone inclines to be soft, comparatively with other greenstones. I observed in it no other foreign minerals than quartz and calcspar in veins and imbedded masses; and balls of reddish flint or jasper (Cape Maurepas). The stratification of this rock is generally very obscure; nearly the whole coast which it occupies, being an assemblage of shivered and displaced masses, or of polished convex mounds piled one above another, with their surfaces now and then also, scarified by multitudes of minute lines including rhombic spaces. It is remarkable for the number of irregular facettes with largely-truncated edges, into which its surface is broken by the waves in many places; resembling certain imperfect artificial crystallizations. Stratification in this rock does not seem to depend on any particular constitution, for all the varieties are amorphous and slaty in places, without apparent cause for the one condition or the other. Three miles south from Cape Choyyè, the direction of some stratified portions is EbN. distinctly, with a northern dip; and a similar position prevails, whenever discernible, throughout the whole south side of Michipicoton Bay. At the place first mentioned, the greenstone is cut by a dyke, or wall, 100 feet high, 50 feet broad, and of length unknown, of the shaly red rock, observed some miles south of Gargantua, but here having in addition to the green earth, horizontal layers of gray, green, and white flint. The foot of this wall on the south is washed by a noisy rivulet; in every other direction it is surrounded by rubbish. I believe it to be connected with the adjacent amygdaloid. My opportunities did not permit a minute examination of it. At $4\frac{1}{2}$ miles and 5 miles from Michipicoton River, patches of conglomerate occur; the paste and nodule being both of this greenstone, in its various forms. They are of small extent. It is to be remarked, that when this conglomerate (if such it be) becomes

schistose, which it frequently does, that the nodules disappear; or may be traced only by their colour, as distributed through several layers. This is common in the Lake of the Woods, and is not unknown in Europe. Major Delafield found resting upon the greenstone bluff of Cape Maurepos, a conglomerate, of flesh-red feldspar in small angular fragments, and grains of colourless quartz in about equal quantities, and imbedded in a little white clay, which is often coloured by iron. It is, in fact, a very coarse variety of the sandstone of St. Mary's and Batchwine Bay; and, of course, is a part of the same deposition.

The foregoing sketch of this greenstone applies to the whole of Michipicoton Bay; the succeeding observations refer only to its north side. The country, about two miles N.E. of Point Perquaquia, is composed of flat-topped greenstone mounds from 20 to 80 feet high, and forming islets along shore. There the mounds run east by north, and without any apparent dip. The rock is in greater part a conglomerate, certain parts being free from nodules. These are of sienite, very quartzy greenstone, often red from iron; and the greenstones of the bay. They are from very small to 40 lbs. in weight, very numerous, mostly oval, rounded, and all firmly set, lengthwise, in the line of the stratification. The matrix is a very dark greenstone. The reticulated fissures above mentioned, are seen here, but they are coarser and deeper. This conglomerate extends, to my knowledge, towards the point on the south-west one mile, and forms some of the islets. Probably it passes through Point Perquaquia (of dark greenstone, reticulated, and obscurely slaty) as it re-appears in the middle of the bay west of that point, and in most, if not all the isles that stud its surface. At Point Perquaquia (famous for the copper said to be once found there), I found a wall (a denuded vein) of white crystalline quartz ten or twelve feet high and thirty inches broad. It is only seen for a short distance, and is lost in the greenstone. Its sides are covered with green incrustations and small spots of copper pyrites.

The large indenture, of which Point Perquaquia is the east angle, is wholly greenstone and its conglomerate, but behind that

point and bay rugged and naked ranges of white conical or steep hills come from the E.N.E.; and in the bay next on the west, approach the lake with a considerable deposit of sand in front. They are of very white, coarse, and somewhat porphyritic, granite, unstratified, and containing very little mica or hornblende. I think it extends along shore for four miles. I observed in it no foreign minerals. From the disappearance on the west, of this granite, the greenstone re-appears; very pale, and with occasional nodules of its own substance. It has numerous drops of limpid quartz, and much white quartz and calcspar in lumps and veins. Except in patches going N.N.W. it is massive. It constitutes the hills in the rear. About three miles east of the Dog River, a rather sudden change in colour ensues, from an increased proportion of chlorite, the rock becoming of the peculiar green tint, soft, glossy, and marked with minute, parallel, tremulous, ridges, running along the breadth of the strata. I have never seen here any chlorite earth, in veins, *&c.*, but I do not doubt of its existence in a separate form. Lieutenant Menzies, 68th Light Infantry, has shewn me very large masses of it from this lake, which may have been taken hence. In Rainy Lake and the Lake of the Woods, it is in large quantity in a similar greenstone. On approaching the Dog River, the stratification becomes clear, and is in small tracts, W.N.W., N.W., N.N.W., and N., the dip being perpendicular or easterly. North-west is the prevalent direction, both here and to the west of Dog River, to within one mile of the crags, when it is decidedly E. and EbN. and for some way along the crags, after having been obscured in the above interval of one mile. Many of the strata about the Dog River contain nodules as about Perquaquia; some many, others very few. There are here fragments of mountain limestone.

The crags are of the various greenstones of this region, the moderately pale green prevailing. It is usually without a very evident stratification; but a little east of the rivulet its layers go N.W. and N.N.W. with an eastern dip. It has many tortuous veins of calcspar and quartz. Somewhat west of the above rivulet, the greenstone, in an amorphous state, intermixes with a granite

resembling sienite; the granite being at first in ramifications; but it augments in quantity gradually westwards, until the greenstone of Michipicoton completely disappears.

This granite predominates from the west end of the crags to within 2 miles of the River Peek, a distance of 73 miles, interspersed with greenstone similar to that just noticed, and traversed in all directions by veins of trap. This rock, which some may be tempted to name a sienite from its abundance in hornblende, disseminated in small crystals, I consider as granite, from the actual, though scanty presence of black mica, the universal and plentiful occurrence of white or limpid quartz, and from the very capricious proportions of hornblende; which I have strong reason to believe is sometimes replaced by chlorite, as I have met with large angular blocks of white granite, containing this substance disseminated, near the west end of Michipicoton Crags. Near the Crags, and for a few miles westwards, this granite, differing from the granular, or small porphyritic kind of Huggewong Bay only in its (usually) increased quantity of hornblende, and in the colour of its feldspar (which is often very red), mingles with a greenstone, which has veins of epidote, and is rarely rendered porphyritic by crystals of feldspar. It is, perhaps, entitled to the name of trap, judging from its small crystalline structure, massiveness, and dark colours.

The line of junction of these rocks is extremely irregular, and neither rock is changed at the point of union. I have observed a string of epidote pass from the greenstone to the granite, unbroken. The latter seems to intrude from below on the former, in whole bluffs, or in large knots, and wandering veins. About two miles west of the Crags, the greenstone is distinctly seen to rest on an inclined and flattened mass of granite, and to receive from it large veins. These intermixtures vary much in their extent; each rock occupying a few yards, or even a mile of the examinable ground between the water and the woods. It is to be remembered that from the inaccessible nature of the country, and the magnitude of the depositions, we seldom see rocks superimposed on each other, on the north side of Lake Superior; and are thus deprived of an

essential aid in determining their relative ages. About seven miles from the crags, or somewhat more to the west, the greenstone trap loses its irregularity of outline, and assumes the form of veins or dykes, which are most numerous during the next ten miles; but, as they prevail in this and other rocks as far as Thunder Mountain, I prefer giving them a separate notice at the close of my remarks on the granite now under consideration. This granite is by no means the exclusive occupant of the coast to the Otter's Head. Having been very variable in its quantity of hornblende in the interval, at seventeen miles from the Otter's Head it is replaced by greenstone for three leagues of very broken country. This greenstone is massive, in low ruinous ledges, or mural cliffs with perpendicular fissures. It is quite black, granular, or small crystalline; or it is the massive pale greenstone of Michipicoton, the colour changing irregularly: occasionally, indeed, an east direction is visible (or EbN.), the dip being either vertical or northerly. About nine miles and a half from the Otter's Head, the greenstone has a distinctly east direction and northern inclination. It here changes colour and composition in a striking manner, transversely to the direction, and insensibly. The hornblende disappears, and a red schistose jaspery matter is substituted, which becomes black, brown, and gray quartzy slate, with just sufficient mica to create a gloss. In the space now under notice the trap veins are seen to cross from the granite to greenstone.

In the eight miles next to the Otter's Head the whole distance is occupied by granite alternating with greenstone, the former being now and then almost altogether red feldspar and white quartz, and at other times being full of hornblende. These alternations aro particularly striking near the east side of the Otter's Head.

About a mile from it a rugged eminence of slaty greenstone from 400 to 500 yards broad, and from 150 to 200 feet high is stratified E. or EbN. perpendicularly, each layer being about eighteen inches thick. It is of the Michipicoton species, and changes its colours as usual. The jaspery substance is here present, which

has been mentioned as occurring nine miles and a half from the Otter's Head. Short intervals of the granite having occurred, two other masses of this greenstone, 50 yards broad, and 50 feet high, are met with westwards; similar in direction, *&c.*, to the larger mass first spoken of. The rocks about the Otter's Head are often mural, though not high; and are dark coloured granite (?) Both the granite and the greenstone of this locality contain calcspar in large masses and veins: and it frequently coats fissures. There are many fragments of mountain limestone on the beaches of this district.

The rocks of the coast between the Otter's Head and two miles and a half from the Peck River, differ from those between the Otter's Head and the crags in the absence of stratified greenstone, and in the somewhat diminished frequency of the trap veins. The granite likewise, in many places, loses nearly, or totally, its hornblende; it being then white, coarse granular, perfectly unstratified, except where from minute and short interleavings of hornblende it assumes the form of gneis. At the Lesser Written Rocks, from thence for seven or ten miles south, and nearly to the Peak westwards, the rock resembles that of Huggewong, being very pale, and abounding in large contemporaneous masses and veins of porphyritic granite, and its irregular imbedded masses of hornblende, mixed with quartz, and traversed fantastically by seams of granite. Veins of white quartz from one to fifty feet thick are frequent here, coated by films of epidote occasionally. The veins are about and beyond the Lesser Written Rocks, in great numbers; never, indeed, being wanting for a great space. I believe them to escape observation frequently from their more common direction being hereabouts parallel to the route of the traveller.

The appearances which I have supposed to be veins, or dykes, are first seen in the crags of Michipicoton near the west end* (not noted before), and, lastly, in the base of Thunder Mountain. In this very extensive range their characters are unaltered, although they traverse granite, greenstone, sandstone, and limestone. They

* With the exception, perhaps, of a fair example near Gravel River in a granitic district.

strike the eye instantly from the prolonged black or iron-rusted channel of undeviating course they trace among ruinous and disordered rocks. Their very various directions, and the hilly nature of the region they pervade, prevents the same individual from being noted through a great distance, but, occasionally, as eight miles west of the Otter's Head, near the Great Written Rocks, and about Cape Verd, they are seen continuously for a mile, and when lost in the lake on one side of a bay, they often emerge at the point on its opposite side indicated by the direction of the vein. They intersect eminences 350 feet high, like a flight of steps, and thus offer the best (though hazardous) mode of ascent, as at five miles east of the Lesser Written Rocks. The passage, from one rock-deposit to another, affects neither their direction, inclination, size, nor composition.

The breadth of these veins varies from a few inches to 60 feet, these extremes, and the intermediate dimensions, also being common. Their sides are usually parallel, but close inspection always detects small angular projections into the inclosing rock. Frequently these are considerable and singular (vide fig. i. and fig. v*.); at other times they are large formal wedges. In fig. vi. (same plate) sudden changes of width take place without the parallelism of the sides being much disturbed. Fig. vii. is an example of the lenticular expansion which sometimes occurs:—here it is in two contiguous veins. This sketch also offers an example, not unfrequent, of a slender tapering mass of granite having insinuated itself into the vein. A still more common fact is the needle-formed slip of basalt (if I may be allowed this name) often projected into the granite. These veins occasionally taper, and almost always are accompanied by one or more branches, which diverge a little, in a serpentine or straight line, from the direction of the parent trunk. It is not uncommon to see large veins subdividing suddenly into a number of ramifications.

Angular masses of the imbedding are sometimes met with in the vein as in the instance sketched in figs. ii. and v. A vein,

* Of the annexed wood-cuts.

two miles and an half east from the Peek River, is filled with very large oblong nodules of the granitic matrix. I saw one example of the inosculation of two nearly equal veins. Their direction is W.S.W.; but in one of their frequent curvatures they join, and are then (10 feet broad) almost as wide as previous to the union. They soon separate into two unequal portions.

By far the most common direction of these veins is N.W.: and it usually ranges between that point and N.E. Any course not included within these limits is comparatively rare. It is in very gentle curves or in straight lines; sometimes, however, without evident cause, breaking off abruptly into a series of strong curvatures. (Fig. iv.) The position is either vertical or inclined. The differences in direction cause frequent intersections; of these I could examine but very few. Thirty miles south from the River Peek, four veins going N.E., cut and displace a fifth passing N.W.; three of the first mentioned set are twelve feet broad each. In the example of intersection, sketched in fig. iii., the place of meeting is filled with rubbish.

These veins occur without any regularity as to size, numbers, or direction, *&c.*; sometimes appearing singly; at others in company. About twenty miles east from the Otter's Head, twenty large veins are met with, passing to the N.W. in the space of 400 yards. This is an extreme case. Four or six are several times seen together. Between the Crags and the River Peek, there must be at least 300 veins; from whence originating I know not, unless from the trap formations of the middle and western parts of this lake. They are composed of fine and large granular, or small crystalline greenstone trap, bluish or brownish black; that is, of a rock in this instance chiefly hornblende, the rest being feldspar and iron. This line of contact with the granite or greenstone, *&c.*, is well defined and close. While the body of the dyke is deep black and large granular, the sides are sometimes almost compact, and greenish black. Ten miles N.W. from the Otter's Head, in a cove of the same bay, in which occurs the vein represented in fig. i., is what may be the ruins of a vein of porphyritic trap; the crystals being of feldspar. From a fissure in a mouldering rock,

there issues into the water a number of angular masses of that substance, fitting rudely into each other. Small ramifying veins of red feldspar are almost universal; and they are often accompanied by white calcspar. A remarkable circumstance in these veins is the prismatic forms into which their more exposed portions are sometimes divided; these outer parts being then composed of irregular columns piled one above another, more or less horizontally, and crosswise to the direction of the vein. These columns are of four unequal sides, and are from eight to twenty inches in diameter. The upper layer (or more) is often displaced; the set next beneath fit closer to those below, while the inferior part of the latter may not be completely divided. The separation thus becomes less and less complete downwards until massiveness is established. This is seen in all the rocks enumerated at the beginning of these remarks, but best in the Pay Plat, in an islet near the east end of St. Ignatius, and near Cape Verd. More commonly the division into columns is incomplete in the upper layer; then the vein seems paved with oblong square masses, lying transversely with their edges upwards.

Greenstone takes the place of the granite, just described, from a promontory among some isles about two miles south of the Peek River, to about five miles N.W. of that river. I am unable to state minutely the circumstances under which the junction occurs. I passed within 100 yards of it. The greenstone of this small district is quite that of Michipicoton;—like it, massive, but here and there shewing traces of a stratification; running N.E. and E.N.E.; varying in its colour and composition by irregular patches, and sometimes in sets of layers; that of the north angle of Peek Bay has a slightly-striated structure, with white crystalline spots of quartz sprinkled over it, and appears in round unstratified hummocks, of smooth and glazed surface. On the south-side of this bay the greenstone is traversed by a well-marked trappose vein. On the main shore immediately north of Peek Bay it is only in a few low detached patches. I am informed it contains seams of chlorite earth.

This rock is succeeded westwards by sienite in diversified forms;

and stretching to the middle of the capacious bay N.W. of Peek Island. This interval is about twenty-two miles long by the canoe route. I have not examined acccurately this rock nearer than two miles and a half from where I last observed the greenstone. Here it emerges from under alluvion, as an unstratified mound of small porphyritic structure and composed of black hornblende with high lustre, and of feldspar in muddy green translucent crystals. It is penetrated by veins of similar materials, but very largely crystallized. The next opportunity for observation occurred three miles westward, at the cluster of casque-shaped isles. They are of indisputable sienite, consisting solely of brick-red feldspar, and light green hornblende, the mass being small porphyritic, passing into large granular, and without stratification. The neighbouring country, I am nearly certain from distant inspection is sienitic. My next landing-place was at the promontory, three miles N.E. from Peek Island, almost a naked heap of mounds of sienite, closely compacted together, and very obscurely stratified in E.S.E. and EbN. directions. It is brownish red, and porphyritic, with the black hornblende, sometimes arranged confused in long crystals. The feldspar is red. There is not a vestige of disseminated quartz in it. It is often very ferruginous; and then is bluish black and brown; and greatly disintegrated. The most largely-crystallized sienite of this headland has many small geodes of crystals of quartz, feldspar, hornblende, and calcspar. Purple fluor-spar occurs in the fissures of the smaller grained species. Mr. Bayfield found here, chlorite in veins, associated with white calcspar. This sienite contains very large irregularly shaped beds of black compact greenstone; which it also traverses in large and small ramifications. It has masses many yards square, of very green hornblende, with white feldspar, which falls out on exposure to weather, and leaves a remarkably ragged surface. The shores of this promontory abound in fragments of blue and brown limestone, now and then four and five pounds in weight each, and containing trilobites, orthoceratites, &c.

On the Cape opposite to Peek Island, the sienite becomes redder, and rather compact and slaty; but I did not discover any

stratification; if it exist. Peek Island is of massive crystalline red sienite, excepting (at least) one of the summits, which is of white quartz, containing hornblende in dots and small crystals, which, although numerous, do not often run into each other *. Among the calcareous debris of this island, I found a very large and well preserved "bouclier," of the Asaph family of Trilobites. From the bottom of the bay, N.W. of this island, the greenstone of Michipicoton returns, as we continue on our tour, and prevails along shore for sixteen miles and a half to about a mile and a half east of the Black River. It is chiefly massive, but at places, as near Cap a l'Ance de Boteille, it is in perpendicular layers, going EbN. and N.E. It has numerous and distinct veins usually running N.W. On the west side of the bay beyond the wall of rock, constituting Cap a l'Ance de Boteille, this greenstone is massive and very pale. It often forms into balls from six to twelve inches in diameter, and composed of thin concentric layers; the structure being marked by shades of green alternately pale and dark. The Slate Islands on this coast have been visited by Lieutenant Bayfield. They are of sienite and greenstone. The first resembles that of the headland three miles N.E. of Peek Island; and the second cannot be distinguished from that of Michipicoton. Mr. Bayfield found imbedded in the greenstone masses of crystalline limestone, two feet thick and twenty long; the terminations being visible. These islands have also cliffs of an ochry red coarse jasper, both hard and soft. I have some of the latter which soils strongly.

There now succeeds to this greenstone a granite, along the main shore for twelve miles to my own knowledge; and extending further, as I learn from Lieutenant Bayfield, whose assistant-surveyor, Mr. Collins (R.N.), has seen large tracts of these rocks stretching as far as the west end of Nipigon Bay. The junction of the granite with the greenstone on the east has not been examined. It consists of white and red feldspar, some white quartz, but not

* Lieutenant Bayfield, R.N., kindly gave me a specimen of this rock.

much; and more or less hornblende, sometimes very little. About the Written Rocks the last ingredient is rather plentiful. There is also a little copper-coloured mica; and a few small garnets. The structure is large granular. There is no difference between this rock and certain forms of the granite west of Michipicoton Crags. Veins of white quartz are common here, usually of moderate size; but half a mile east from the Black River a vein occurs from three to five yards broad, containing films and masses of granular epidote, on which is deposited purple fluor spar. Trappose veins in every respect similar to those around Otter's Head are occasionally met with in this granite, going W., W.N.W., W.S.W., *&c.*

The craggy line of shore, ending on the west in Cape Verd, is of the greenstone so often met with; but the interior, a mile or so in the rear, still consists of the red granite of the Written Rocks; and so continues along the main for a great distance into Nipigon Bay. This is, therefore, the northern portion of a greenstone deposit covered by the lake. At the east end of this line of cliffs and shelves it is the usual pale greenstone; but in displaced and weathered masses buried under a profuse vegetation. It however darkens gradually, and at the west end is very black, and contains knots and coatings of white calcspar, which drop out, leaving the rock vesicular. I landed near, and found the several hues of greenstones intermixed in a curious manner; but which I had not leisure to unravel. There are here also balls of concentric laminæ, the same (except in being darker) as in the greenstone immediately east of the Black River. Large and extremely well characterized trappose veins traverse the greenstone.

The north shore of Lake Superior from Point Marmoaze to Cape Verd, has presented a series of rock masses of great extent, succeeding each other abruptly and without admixture, but connected strongly by the similarity in composition of its several alternating members, respectively, and by the presence of trappose veins in all; and of calcspar, a mineral unusual in some at least. Fluor occurs in the granite, sienite, amygdaloid, and porphyry. We now enter among rocks still more closely allied; but such is the intricacy of the region in which they are placed, both as to its

geology and its geography, and so inadequate is the attention hitherto bestowed upon it, that almost every thing toward its elucidation on these points is yet to be done.

The rocks of the main of Nipigon Bay are granite, greenstone, and red sandstone, as far as is yet known;—those on the north side of the insular groups at its mouth, are red and white sandstone, and conglomerates, reposing, in some instances, on amygdaloid, while, on their south side, porphyries and amygdaloid exclusively are met with. The rocks of the Mammelles, and of the skirts of the Black Bay, except a small portion on the west of Gravel Point, are amygdaloidal and simple trap, with red and white sandstone. This sandstone, with its occasional concomitant, puddingstone, is now first again seen from the vicinity of Marmoaze (except at Cape Maurepas), and extends from the east end of the Pay Plat to the Grand Portage, at least, a distance of 140 miles. At the latter place, slabs of this rock occur, whose uninjured state denotes its proximity *in situ*, in which form it has been observed on the main by Mr. Thompson, twenty-two miles west of Fort William. It is quite the predominating rock on the inner side of the Nipigon Belt of islands, and exists at all levels, interspersed with small, unconnected, and unfrequent, patches of amygdaloid, westwards; it is then lost until it re-appears in the cliffs in the isles at the mouth of Black Bay; there also contiguous to trap, simple, and amygdaloidal. It lines the south side of the base of Thunder Mountain, and is occasional, as debris to the Grand Portage. Isle Royale, and the islands between it and the north main, have not been examined.

The colour of this sandstone is uniform throughout considerable spaces, and is white, reddish yellow, brownish, and brick red. Fifteen or sixteen miles, however, from Cape Verd, this rock is spotted and clouded like that of Batchewine Bay. It is generally coarse granular, consisting, as far as the eye can discover, of quartz nodules—with a scanty cement of calcareous, ferruginous, or clayey matter; but a specimen which I found in actual superposition on amygdaloid, near the N.W. corner of St. Ignatius, is fine grained, ferruginous brown, and having a faint lustre, when

held in certain lights. It effervesces moderately in acids; and is very slaty, and weathers readily. It is generally horizontal. At the north angle of the most easterly large island of the Pay Plat, the layers undulate in small sets; these sets, however, being, by no means, parallel to each other; often, indeed, straight and horizontal. Lieutenant Bayfield favoured me with a sketch representing sandstone and conglomerate incumbent on amygdaloid, in the sides of a narrow entrance to a cove in an island in the Mammelles, fourteen miles east of Thunder Head. The sandstone is here stratified in gentle curves, concave towards the amygdaloid, on which it is placed. Most commonly the sandstone is detached from other rocks; and is surrounded by woods.

The puddingstones which accompany this sandstone vary:—in some cases the cement is sandstone; but generally near inspection proves it to be greatly comminuted fragments of the rocks constituting the larger nodules. White calcspar is often present among the cement; sometimes in very great quantity. There is often green earth. The nodules are very numerous and diversified. They are not so much worn as in every case to have lost their angles. They consist of the amygdaloids and porphyries of the district, especially of the latter, only having small masses of limpid quartz, of red granite, like that ten miles west of the Otter's Head, pale and dark greenstones, translucent crystalline and opaque granular quartz, sandstones, and jasper. The size of these nodules, and the aspect of the conglomerate, *en masse*, is the same as at Marmoaze.

This conglomerate, according to my experience, is confined to the north side of the Nipigon islands. I have only seen it rising out of the water solitarily in low and shattered amorphous patches; but Lieutenant Bayfield has observed it overlying white and red sandstone, incumbent on amygdaloid; while Major Delafield has met with it between amygdaloid and sandstone.

The amygdaloid of the Pay Plat and Mammelles differs from that of the east coast of the lake only in being less ferruginous, and in the occasionally darker tinge of its green earth. The imbedded substances are in smaller proportion. In fact, the amyg-

daloid frequently loses them altogether; becoming insensibly a homogeneous amphibolic rock, having a trifling portion of feldspar, now and then barely visible. A lofty isle, fifty miles east of Thunder Headland, in the Pay Plat, displays a cliff of this kind fissured vertically; and defended at its base by a shapeless deposit of one of the conglomerates described above. I cannot determine the mutual relations of these rocks. The Grange, and many low isles in the Mammelles, are of this trap. The amygdaloid of these regions may be stratified, but I could not detect the fact. When free from foreign matters, it is massive; when full of them, it is decayed and broken into accidental forms by the waves.

From one mile east of the Detroit, on the outside of the island of St. Ignatius, to rather more than two miles west of Gravel Point, a distance of twenty miles and a half, porphyries prevail along the Canoe Route. Like the other rocks of Lake Superior, this porphyry is found at all levels, its rude colonnades plunging into the waters and crowning the highest summits. Having never seen this rock in contact with any other, and having never observed a decided stratification, I can only speak doubtfully of its relation to the formations around it; but the following facts bespeak a certain connexion:—Major Delafield and myself, separately, have noticed bowlders of well-characterized porphyry, which contain the rounded masses of calcspar, common in amygdaloid, and coated with green earth; a substance, abundant here, disseminated, and colouring the rock. The calcedonies, fluor, veined and fortification agates also of the amygdaloid, are frequent in the porpyhry; except the second, which is only occasional. Its base is argillaceous chiefly, and when exposed to weather becomes pale reddish white and powdery. It can then scarcely be distinguished from a species from Arran. I have strong reason to believe that this rock passes into the sandstone of St. Ignatius, *&c.* Considerable tracts of it exist on the south side of this island, wholly deprived of its feldspar crystals, and having only here and there a small fragment of limpid quartz in a more or less compact red cement: and great portions there below water-mark lose even these vestiges of their

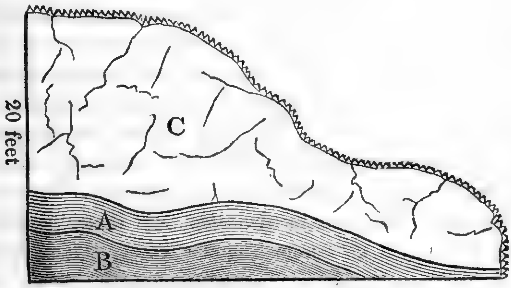
original form, become slightly granular, of red, white, and yellow colours, and even seem stratified horizontally: of the latter fact I should have rendered myself more assured, had my leisure allowed.

The mineralogical characters of the most common form of this porphyry are nearly the same as of that of Gros Cap. If I had seen more of the latter rock I might have found the varieties existing here. The colours are brick, and brownish red, brown, black, gray, and green, varying in clouds: the lustre of the cement is dull, and the fracture uneven. A gray streak is yielded easily to the knife: but sometimes it is not scratched by steel. A strong earthy smell is emitted on the application of water. In the passage leading from the Nipigon route to Gravel Point the cement is hornblende; but often containing so much glassy feldspar in large crystals, as nearly to disappear. The imbedded substances are vitreous feldspar in six-sided unequiangular prisms, rectangular and oblique four-sided prisms, usually broken and compressed; and in size, from microscopic to an inch long. Their colours are opaque white in a dark red base, transparent and colourless in a light red ground, pale red and translucent in a greenish black mass, and transparent yellow on a black base. Every hand specimen contains crystals more or less weathered. They are numerous, but do not often run into each other. This feldspar is almost always accompanied by roundish drops and fragments of transparent crystalline quartz. Green earth and other substances occur as mentioned above. Lieutenant Bayfield presented me with a group of octahedral crystals of green fluor associated with straight lamellar barytes. He found it in a vein in the porphyry of the lofty island three miles east from Gravel Point.

The pale varieties of this rock are extremely full of parallel rents and fissures, but, even after many endeavours I could not ascertain any determinate stratification. The amphibolic species is in very steep, smooth, hummocks.

From the magnificent headland, Thunder Mountain, greenstone trap predominates to the River St. Louis: my personal examinations have only extended to the Grand Portage.

Thunder Mountain is one of the most interesting localities in the lake; it has been the least studied. I have passed along its south side twice:—at the first time enjoying a transient but near view; but the second journey was so rapid and distant from the shore that I could only verify the more prominent of my former remarks. I must content myself therefore with a brief detail of the facts actually noted. Limestone, sandstone, conglomerate, amygdaloid, greenstone trap and sienite are close together here; and in a singular state of disturbance. At the west end of the traverse of six miles and a half from the isle about the mouth of Black Bay to the base of Thunder Mountain, there is a bluff point of rock, a good deal shattered; whose west side, perpendicular and about twenty feet high, has the following appearances. The lowest visible rock (B) is a fine shaly red sandstone of clayey



base—perhaps four feet thick: it dips with undulation to the E.S.E.? at an angle of 20°, and supports a conformable stratum of limestone (A) from three to four feet thick, light gray, passing into ash brown, compact and fine granular in parts, subdivided into smaller layers, and having small and large interleavings of pale chert. It is without fossils. The rest of the scarp is an amorphous rock (C) red and pale brown in clouds, full of rents in every direction. It is principally of clay; with small knots of white calcspar and a little quartz. It is of sound texture. A few hundred yards hence into the lake are reefs of amygdaloid: and the adjacent hill displays the pilasters of greenstone trap. A sin-

gular fact is the intersection of this point, three or four yards from the scarp above noticed, by a trap vein, or dyke, about a foot thick. It mounts the rocky point from the lake, like a flight of steps, and is lost in the shrubbery contiguous. It is represented in the annexed sketch by a zigzag line;—not quite in place.

Close on the S.W. of this point (on the way to Fort William) are other small layers of this limestone, horizontal, and interleaved with a seam or two of the red shale of the scarp; and in a cove three-fourths of a mile further S.W., this red sandstone overlies the grey limestone; for such I suppose this last stratum, although I have not had an opportunity of testing it by acids. It is frequently seen both under and over the red sandstone, and by itself, in the rocky ledges emerging from under the small beaches of this coast. About mid-way between the first-mentioned point and Thunder Point, a broken ridge of greenstone trap cuts through these horizontal rocks; which, however, soon recur westwards for 500 yards, and are then replaced by the trap nearly to Thunder Point in the form of a wall of moderate and varying elevation, washed by the waves, and supporting the ascent of broken terraces at the foot of the mountain. This trap contains several patches of conglomerate, whose large black nodules are imbedded in a dark and, probably, trappose cement. The exact nature of this conglomerate and its relation to its enclosing rock I am ignorant of. Three quarters of a mile from Thunder Point, ragged angular masses of slaty rocks (almost certainly sandstone), ten, twenty, and thirty feet in diameter are completely enveloped in the trap; in accidental positions, as indicated by the direction of their layers. The above distances are conjectural; but the appearances just mentioned, are so striking, that they cannot well pass unnoticed. Near Thunder Point there are reefs, (besides others on this side of the mountain) rising out of the lake in fixed blocks of dark gray sienite, or rather of greenstone trap, whose feldspar is in visible white grains. It lines the adjacent point in large quantities of angular debris mingled with the common form of the latter rock, and sandstone, amygdaloid, limestone, *&c.* Hare Island in Thunder Bay, consists of this sienite, but the feldspar is neither so distinct

nor so plentiful; the greater part of its rock is bluish black, fine granular, or compact. The strongest cleavages pass N.N.E., but none are so marked and continuous as to point out a stratification.

I had it not in my power to examine minutely the mineralogical characters of Thunder Mountain; but the native debris strewn along its base, its general features, and the form and weathering of its pallisades (as a similar but far less splendid structure on the River Hudson, New York, has been named) are evidences of its complete identity with the rocks of the coast from hence to the Grand Portage, and in longitude 90° forming the height of land between the waters of Lake Superior and Hudson's Bay. It is a greenstone trap passing from sienitic to homogeneous; and I think gradually. The most common forms are, moderately fine granular and small sienitic; the feldspar, in the latter case, appearing in white, or brownish gray rhomboidal facets, or in grains. The colour is dark blackish brown, bluish black, and even red, from the presence of iron. The fracture is conchoidal when massive—when schistose, the cross fracture is uneven or earthy. The fine grained and compact greenstone traps are usually (but not always) in the lower parts of the cliff, in horizontal layers, eighteen inches broad, and diminishing to the state of shale. The upper parts again, are often crystalline and almost always fissured perpendicularly, from one foot to ten or fifteen in breadth, and of great length. They are rendered prominent and conspicuous by the truncation of their lateral angles. The transition from the vertical to the horizontal fissure is effected in the following manner. In the variable interval between these two appearances in their perfect form, the place of the pilastres is shewn by perpendicular fissures; some of these gradually vanish, while others, being prolonged, curve at their lower ends rather sharply upwards, and then close; succeeded below by short and interrupted rents, waving, or rather discoid, and always more or less horizontal. These soon become (downwards) straight, and finally, continuous lines. One of the Welcome Isles in Thunder Bay affords a good instance of what is here attempted to be described. It is by no means singular to have the vertical and horizontal fissures equally strong, or nearly

so, in the same part of a precipice, thus producing a rectangular reticulation on its surface. This sometimes occurs and ceases suddenly, and without the preparatory steps described above. It is well seen at the southside of the west end of Thunder Mountain, in the fine cliffs of the Entredeux, a very beautiful lake, on the old route to the Lake of the Woods, and in many other places.

In the neighbourhood of Pigeon Bay, this greenstone trap contains black flint, so conchoidal, splintery, and of lustre so considerable, as to resemble pitchstone. I have only seen it there as debris ;—but it occurs in this rock in horizontal layers, gray and black at the Mountain Fall of the Dog River, according to Major Delafield. This gentleman also found at the Outard Precipice, overlooking the lake of that name in the old route to the Lake of the Woods, small veins of white satin spar, in greenstone trap. Calcspar is a frequent mineral in this rock, in veins and imbedded masses. Its fissures are often filled with quartz crystals—which now and then are amethystine. The slaty trap west of, and contiguous to Farther Point, contains oval and circular balls of concentric layers six and twelve inches in diameter. They are light brown and coarse granular in the centre; but more compact externally; and pass into the ordinary form of the rock by the rapid fading of the discoloured rings marking their successive coats.

I remarked at Pigeon Point a reddish porphyritic rock; this Major Delafield, who landed there, has determined to be red granite, but without either hornblende or mica. Further west large grained massive greenstone trap mingles with the slaty form. At Point Chapeau I found the trap in cuboid blocks, with its white feldspar very distinct.

From distant observation the islands from Fort William to the Grand Portage seem to be trappose, mixed, I do not doubt, with sandstone. The pilasters of the most lofty, such as the Patè, bespeak the nature of their geological structure, while that of the lower isles is explained by the vast quantities of fragments, accumulated on the shores of the main, of simple greenstone trap, amygdaloid, red and white sandstone, white limestone, and the amorphous red rock of the point described in above.

Mr. Thompson informs me that the rocks of the north main, between the Grand Portage and the River St. Louis are chiefly composed of hornblende. The cliff, sixty miles east of that river is, probably, greenstone trap. He adds, that at fourteen miles and four miles and a half east of the same river, granite makes its appearance.

I now subjoin a hasty outline of the geology of the south shore of Lake Superior. From Mr. Schoolcraft we learn that the south shore is, on the whole, sandy, from Point Iroquois to the Pictured Rocks; that, in this interval, the Sand Hills ("Grandes Sables") immediately west of the Grand Morais, (ninety-three miles trom St. Mary's) present to the lake for nine miles a steep acclivity 300 feet high, composed of light yellow siliceous sand, deposited in three layers 150, 80, and 70 feet thick respectively, the last-mentioned being the uppermost, and like the lowest, pure, while the middle bed has many pebbles of granite, limestone, hornblende, and quartz. Three leagues west from this scaur, the Pictured Rocks commence; and continue for twelve miles along shore. They also are 300 feet high, are stratified horizontally, of a gray colour in the fresh fracture, but stained by the weather of various tints. They consist of a calcareous cement enclosing coarse grains of sand. From this place to Point Keewawoonan, the coast is rocky, but with occasional arenaceous deposits. The predominating rock is red and gray sandstone, of calcareous and ferruginous cement, the nodules being principally of quartz, with a few of hornblende and other rocks. It is usually horizontal, but at Train Isle, it dips to the N.E. Granite seems to occur plentifully from Granite Point westwards: and first shews itself there, to the traveller coming from the Falls of St. Mary. It is described by Mr. Schoolcraft in his sketch of Granite Point:—"A bluff rising out of the lake to the height of 200 feet, connected to the shore by a neck of land, consisting of red and gray sandstone in horizontal layers. This granite is made up of red feldspar, quartz, and a little mica, and very much mixed with hornblende. It lies in a confused bed, presenting perpendicular fissures, and traversed by regular veins of greenstone trap. These veins of greenstone vary from two to thirty feet in width, and are disposed to break

in irregular columnar fragments *, resembling in some degree the columns of true basalt. The sandstone laps upon the granite, and fits into its irregular indentations in a manner that shews it to have assumed that position subsequently to the upheaving of the granite. Its horizontality is perfectly preserved, even to the immediate point of contact which is laid bare to the view. A mutual decomposition for a couple of inches into each rock has taken place. Dipping under the sandstone, the granite again rises on the contiguous coast in high, rough, and broken hills *." Near Deadman's River, and at a place fifteen miles westwards, the sandstone again overlies the granite directly and horizontally.

Point Keewawoonan, opposite the Mammelles (a district of amygdaloid), and not much more than fifty miles distant from it, and, at the same time, about forty miles from Isle Royale, I am told by Mr. Thompson, is wholly or principally trap, simple and amygdaloidal; quite resembling the last rock at Gargantua, and containing the same minerals; as zeolite, *&c.* While circumnavigating this promontory in 1822, Mr. T. found immense quantities of pale and dark green malachite in veins, and disseminated, in the rocks of a bay in long. 87° 59'., about six miles west from this point. He has named it Copperas Harbour. It is defended by two islets. In a fine specimen, presented to me by this gentleman, the ore is interspersed in thick coatings and plates through a dark hornblende trap. I found several specimens of the same ore at the west end of the Mammelles, in bowlders of sienite, very like that of the casque-shaped isles of the Peek. I believe that the locality, examined by desire of Mr. Schoolcraft in 1823, and described by him in the *American Journal of Science*, vol. vii. p. 45, to be Copperas Harbour; although this last is not exactly at the end of Keewawoonan Point. The mineral brought thence by Mr. Thompson and by Mr. Schoolcraft's agent are the same:—and their descriptions of the place correspond pretty well. Mr. Schoolcraft's account is as follows:—" The precise locality of this ore is the

* The rocks here described are a continuation of those west of Michepicoton Crags.

* Schoolcraft's *Travels*, p. 158.

extremity of the great peninsula of Kewüweenon. In traversing around this peninsula, they must pass a small bay and point of rock, known among the Canadian boatmen by the name of 'La Roche Verte,' which is, in fact, the vein of copper ore, where it juts abruptly upon the lake. The vein of ore is about one fathom in width, rising with a broken surface out of the water, and it extends in a direct line from the lake into the interior; its course being marked upon the bed of the lake, by a broad green stripe, seen through the water, and upon the shore by parallel walls of the enclosing rock which constitutes the matrix to the ore."

From the west side of the Portage of Keewawoonan to the Porcupine Mountains, the lake shore, excepting some red sandstone off the Iron River, and a few other limited spots, consists of sand, here and there intermixed with clay and bowlders; and extending far into the interior, as is well-exemplified on the upper parts of the Copper-Mine River. I have seen porphyritic red granite with large plates of mica from the Porcupine Mountains. Between the Black* and Montreal Rivers, and for four miles beyond the latter, there is an extensive range of cliffs of red vertical sandstone, capped by a bed of red clay twenty-five feet thick, and bearing poplars and birch.

From the last-mentioned place the remainder of the coast to the St. Louis, including Point Cheguimegon, the headland opposite to the "Twelve Apostles," and the south shore of the Fond du Lac, is wholly lined with sand which is often ferruginous; and is backed by hills of the older rocks. Mr. Thompson has remarked, that the sands forming the beeches of the south shores of Lake Superior, often stretch in rude terraces, and a sort of thinly-wooded country, far into the interior; and fur traders have stated to me that many of the small lakes, an hundred miles or more on the south, are surrounded by sandy barrens of irregular and great extent.

* Not named by Mr. Thompson; but Mr. Schoolcraft makes it twenty-one miles east from Montreal River.

To the foregoing details I beg to add a few observations:—

Lake Superior abounds in proofs that its waters have been in vastly greater quantities than at present: and, it may be presumed, that its subsidence has been effected, not by slow drainage, but by the repeated destruction of its barrier. That lakes Michigan, Huron, and Superior, have been one body of water, is rendered certain, among other stronger considerations (which having been urged before, I shall not now state) by their comparatively low dividing ridge, and by the existence in Batchewine Bay (L. S.) of numerous rolled masses which are *in situ* in the N.W. parts of Lake Huron; as the jasper puddingstone, near the head of St. Josephs (L. H.); the greenstone puddingstone of Pelletau's Channel (L. H.); and the crystalline quartz Rock of La Cloche (L. H.). This opinion is strengthened by the very large bowlders of the Huggewong granite, and the greenstone of Michipicoton, strewn, in company with rocks of Lake Huron, over the Portage at the Falls of St. Mary. Their original situation is, at least, 100 miles north from where they are found at present.

In aid of the supposition that Lakes Huron and Superior (including Michigan necessarily) have been at a much higher level than they are at this day; the beds of sand and clay in their islands and on their main may be instanced;—in both cases the work of the lakes themselves, united or distinct. While on their north shores these are small; on their south shores they are high and very extensive. But the north coast of Lake Superior is not in the uniform and extreme state of nakedness, represented by former travellers. It presents occasional tracts of sand, and even of clay, of some magnitude; which, however, do not always produce fertility. I refer to large gravelly beds (170 feet high) about the Black River (north shore), those of sand and clay, still higher, perhaps, of the River Peek, and the terraces of the east of Otter's Head, Michipicoton, Huggewong, *&c.* The south side of the height of land between Lake Superior and Hudson's Bay is covered here and there, as on the Grand Portage, Partridge and Outard Portages of the old route to the Lake of the Woods, with red viscous clay (sometimes coloured brown by iron), and consequently

with a dense vegetation. Mr. Sayer, an intelligent man, formerly a clerk in the employ of the North-West Company of Fur Traders informs me, that there is a ridge of maple growing on an argillaceous soil, which extends, at least, twenty miles westward from near the Grand Portage. To this the neighbouring Indians resort to make sugar. At the back of Michipicoton Fort, Mr. M'Intosh, the superintendent of that post, says that there is another maple ridge ranging parallel with the lake for a long way.

With the exception of the vicinity of Missipaga, parts of the Spanish River *, and some occasional spits of sand at the mouths of certain rivers, the north of Lake Huron, as far as I am aware †, is altogether composed of naked rocks; but, besides the clay cliffs on the S.E., the fifty-five miles of east coast from Penelanginshene, the British naval station, to the south side of Notawasaga Bay, consist of two, and sometimes of three undulating platforms of alluvion, several hundred feet high, rounded into knolls and intersected by water courses, and extending to the N.W. shores of Lake Semcoe, and, in fact, to Lakes Ontario and Erie. They are at this part of Lake Huron of siliceous sand, brown, and often ferruginous, intermixed with pale and dark blue clay, and covered with blocks of mountain limestone, Labrador feldspar, gneiss, and greenstone. They are proved to be deposited by fresh water, in a beautiful manner, by the frequent occurrence in them of the shells that now inhabit the lake. About twelve miles from the lake, and three from the head or the rapids of the picturesque River Notawasaga (whose sources are in the forests and morasses near to, and west of, Lakes Simcoe and Ontario), and on its right bank, there are two horizontal layers each from four to six inches thick, of large shells, of the genus Alasmadonta, common in the

* This the largest river entering Lake Huron, except St. Mary's, was only known to Indians and a few traders until explored in 1820, by Lieutenant Bayfield, R.N. Neither it, nor its great bay (or sound), is represented on any map.

† The Canoe Route down the north shore frequently leaves the main for miles together, and traverses successive dense Archipelagoes of islands.

lake at the present day, but much thicker, and, of course, heavier. They are one or two feet apart, and are buried under 150 feet of sand, in various degrees of preservation; from being nearly sound, to a state of pulverulence resembling calcination. They, most commonly, are composed of loosely-cohering layers of soft calcareous matter, with a very bright pearly lustre; and, therefore, are very fragile. Both valves are often in undisturbed contact, having the interior filled with small shells and sand; but many are broken into small fragments and disseminated in white powder through the containing sand. They are never fossilized. The smaller shells alluded to are Planorbes, Physæ, Lymnæi, Melaniæ, and Paludinæ*, which are particularly abundant in Notawasaga Bay in a living state. While the alismadontæ are compressed into layers, these are scattered for a small distance through the neighbouring sand. They are occasional in a loose state on the banks and bed of the river from near its north source to the mouth.

The occurrence of fresh-water shells in the great alluvial beds on the east of Lake Huron, appears to argue them to be a postdiluvian operation; effected while the waters were still of immense height and extent;—and the idea is confirmed by the fact, that in Lake Superior, the materials of similar deposits, in most cases, belong indisputably to the vicinity in which they occur; as at Huggewong near Montreal River, where the rounded masses of the sand-bank are of the white granite of the place; as at the head of the River St. Mary, where the sands have the ferruginous tint of the red sandstone on which they repose; and as the Black River where the gravel consists of the greenstone, pale red granite and quartzy matters of the district.

In addition to the movements in these great collections of waters arising from storms, lunar attractions, and sudden drainage, or any other cause, a powerful agent in breaking up and removing rocks,

* Precisely the same shells exist in a marl bed, laid open in the summer of 1823, by the cutting of La China Canal, near Montreal, in Lower Canada.

and in depositing beds of clay, sand, *&c.*, has existed in the current, supposed by Mr. Hayden* and Professor Buckland, to have traversed North America from the N.E. The shores of the St. Lawrence, and its lakes afford further evidence in favour of this hypothesis in the removal of enormous rock masses from their known depositaries (contrary to the present current of the rivers), from N.E. to the S.E., or nearly. Large fragments of the trap rock of Montreal mountain, remarkable in itself, and abounding in crystals of augite, zeolite, and hornblende, are found one hundred and ten miles on the S.E., up the St. Lawrence, and on the south around the head of Lake Champlain. Vast blocks of the ophicalcic rocks of Grenville on the Ottawa River, are found, on the S.W., near York, on the west of Lake Ontario. The crystalline white marble of the higher parts of the Ottawa is distributed in great quantities over the shores of Lakes Ontario and Simcoe. The numerous bowlders of the portage of St. Mary have been traced to Lake Huron and the N.E. coast of Lake Superior. The calcedonies and agate, of the north shores of Lake Superior and Point Keewawoonan have travelled as far S.W. as Lake Pepin, an expansion of the Mississippi (Schoolcraft). Much of the south shore of the former lake is covered with the debris of the amygdaloid of the north. The large rolled mass of copper, lying under a high gravelly bank from thirty-six to forty miles up the Ontonagon, is almost surely from Keewawoonan on the N.E. The south and west shores of the Lake of the Woods†, are loaded with sand and bowlders, while the northern and east shores are comparatively destitute of them. The bowlders are sometimes of immense size and angular. They are granites, greenstones, greenstone puddingstone, and limestone; the two first only being now and then referrible to their original situation on the north shore. The lime-

* In an original and valuable work, entitled *Geological Essays;* published in 1820, at Baltimore.

† Not the Lake of the Woods, mentioned by Captain Franklin, R.N.; but the lake in north latitude 49°. and west long. 49°. 30′. and 450--500 miles in circumference.

stone is very hard, compact, or fine granular, white and yellow; in slabs and angular thick masses, frequently weighing a quarter of a ton. It is crowded with various forms of productæ, turbos, orthoceratites, turbinolia, trilobites, *&c.*, *&c.* From their very frequent occurrence, great dimensions and angular shape, I believe them to be very near their parent rock.

In the description of the rock formations of Lake Superior I, perhaps, have used too great minuteness; but, in the present state of geology, it is the safer error; and, especially, as regards these distant and melancholy wilds, whose few visitors are only anxious to escape from them.

The rocks of Lake Superior are few in number, when compared with those of a similar extent of country in Europe; but those few are on an immense scale. Of mica-slate, clay-slate, *&c.*, there is not a vestige; not even in debris; nor of any of the numerous secondary deposits above the mountain limestone. Sandstone, under various modifications, occupies the greatest space; in intimate connexion with the next prevailing rocks, the amygdaloids, porphyries, and greenstone trap. The alternating granites and greenstones of the north-eastern and eastern coasts, are nearly equal in quantity to these. The last-mentioned rocks, including the sienite of the Peek are the oldest, and seem to be of the same age, and to belong to the transition class, or to the youngest of the primitive. I have fixed upon this epoch from the remarkable proportion of hornblende in the granite, and its being, in one instance, replaced by chlorite earth; from the plentiful occurrence of calcspar, the interstratification of conglomerate, true and simulated, in the greenstone of Michipicoton, the great numbers of trappose veins traversing all the formations indifferently, and, finally, from the passage (if I be therein correct, as I believe myself to be) of the Huggewong granite into amygdaloid. These granites and sienite are not stratified, but the greenstones interposed in such vast masses, with an eastern (or EbN.) direction, and a vertical or northerly dip, indicate the order of deposition and its breadth. On the old route from Lake Superior to the Lake of the Woods, this alternation of chloritic greenstone and amphibolic

granite is continued over the height of land, through Lakes Keseganaga, Cypress, Couteau, and Boisblance, but in the northern parts of this route*, as Lakes Namaycan, La Croix, La Pluie, and of the Woods, the same greenstone frequently passes into gneis, mica slate, traversed in a thousand fantastic forms, and in great quantities by graphic granite; the former rocks running E.N.E.†, and dipping in a majority of instances, northerly, as Dr. Richardson has observed in the lakes N.W. of Hudson's Bay, and as occurs in Lake Huron, and on the north shore of the St. Lawrence below Quebec.

The porphyry, amygdaloid, and sandstone, I consider contemporaneous; of course, newer than the granites, *&c.*, above spoken of; although not much, according to the transitions and alternations occurring about Gargantua. I am not at present prepared to state the age and connexions of the greenstone trap. The sandstone is, most probably, the old red, as I am led to conclude from the materials composing it, its direct superposition on inclined rocks in this and other of the great Lakes of the St. Lawrence, and from its supporting a blue, white, or gray chertzy limestone full of productæ, turbinoliæ, caryophylliæ, trilobites, conulariæ, encrinites, and orthoceratites, *&c.*

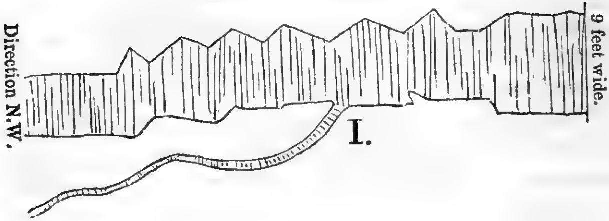
This subject is more fully discussed in the eighth volume of the *American Journal of Science.*

New York, May 1, 1824.

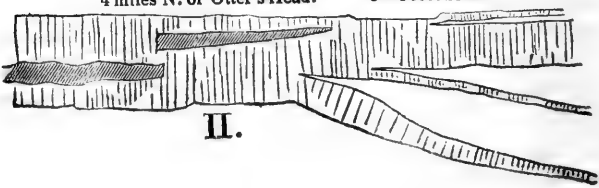
* Four hundred and thirty miles to the north end of the Lake of the Woods.

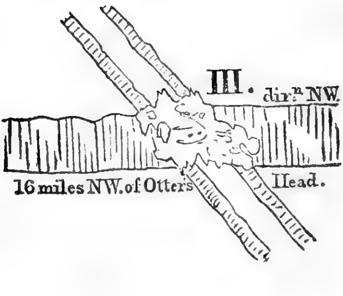
† In these counties there is 13°. and 14°. of east magnetic variation, diminishing southwards.

10 miles N.W. from Otter's Head.

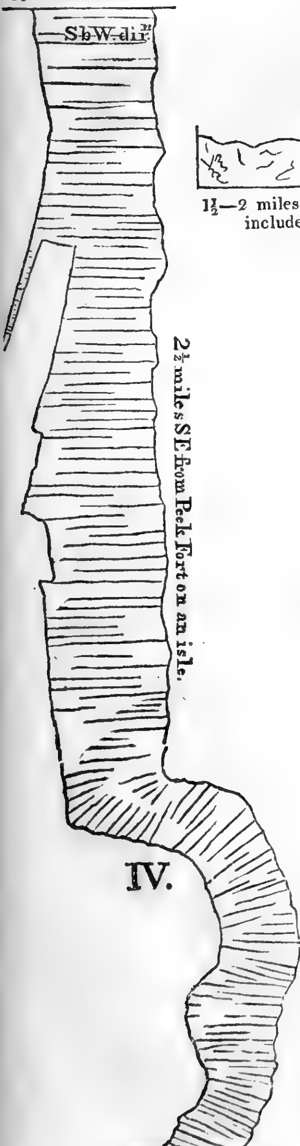


4 miles N. of Otter's Head. 6—8 feet broad.



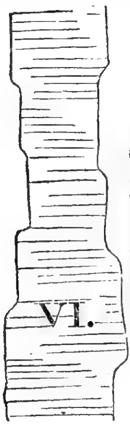


10—12 feet broad.



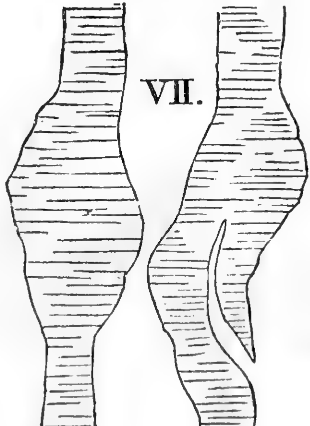
2½ miles SE from Peek Fort on an isle.

1½—2 miles N. from Otter's Head. This may be a bed, as this sketch includes all that is visible. The cross fissures are indistinct.

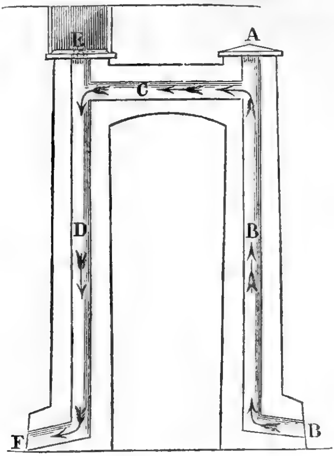


7 miles W. of Mich. Crags.

9 miles W. of Mich. Crags.



Art. IV. *A Description of a Method invented by* Mr. Jeffreys, *of Bristol, for condensing Smoke, Metallic Vapours, and other Sublimed Matters, by which they are prevented from passing off into the Atmosphere.*



It is hoped the following explanation, aided by the Diagram given above, (which is meant to be a vertical section) will be sufficiently clear and intelligible.

The letters BB, are intended to point out a flue by which the smoke from a furnace, applied to any ordinary purpose, is carried off. By Mr. Jeffreys' plan, the top of this flue is closed up, as at A., and the smoke, *&c.*, pass, by a lateral communication, which is here represented by the horizontal flue C, into another chimney or flue D. On the top of this flue D, is fixed a cistern E, the bottom of which is perforated with holes, the size of which will necessarily vary according to existing circumstances, but they should spread over the bottom of the cistern to an extent equal to the area of the flue D, that the shower of water which is perpetually passing down from the cistern, may be equally diffused throughout. The cistern, of course, receives a supply of water

equal to the expenditure through the holes in its bottom. The shower, in its descent, carries down with it the smoke, and all the sublimed matter which has passed from the fire, in the direction pointed out by the arrows, and the whole, thus condensed, runs off from the flue D, at the opening F.

Although the drawing gives the lateral communication between the flues B and D in the manner described, it will be obvious, on reflection, that these flues may stand so close to each other as only to be separated by a party wall. Or D may stand at any, and almost an unlimited distance from B (which may run in any direction that may be found convenient) without lessening the draught of air, provided that the matters which pass through it enter the flue D immediately under the cistern E, with a view to make the condensation by the shower of water as complete as possible.

When it is considered, that water and air have a mutual attraction for each other; that all bodies expanded by heat, are contracted by cold; and that the motion of bodies in falling, is accelerated as the distance they fall through is increased, it must be evident, that by a due attention to these several causes, and a proper application of them, such a current of atmospheric air may be made to pass through a furnace, as, perhaps, was never yet attained.

It was not this application of the principle that first suggested the idea of effecting condensation by this mode, but in seeking a remedy for the baneful effects produced by arsenical and sulphureous vapours, sublimed metals, and other matters which spread so widely in all directions, around those works where the smelting of metals is carried on.

Though it is hoped the public may derive advantage in various ways from the application of this invention, and, more especially, where the expense of carrying it into effect bears but a small proportion to the advantages that will accrue, still it may be expected that many instances will be found, in which the difficulty or the expense of procuring the necessary supply of water, and possibly, other causes, will operate as a total bar to its adoption. On the

other hand, it is not improbable, that time and reflection may discover remedies, which, at the outset, may not occur.

Bristol, November, 1824.

N. B.—Mr. Jefferys has taken out a Patent for this Invention; and we understand that its efficacy has been very satisfactorily proved by experiment. The draught of air through the furnace was prodigiously increased; and although the ascending column of smoke was rendered as dense and black as it could well be made, yet not a particle of smut or smoke was observed to escape by the vent at the bottom of the water-flue. A strong current of air, and a stream of *black* water issued forth, but nothing like smoke.

Art. V. *A Monograph of the Genus Ancillaria, with Descriptions of several new Species.* By William Swainson, Esq., F.R.S., F.L.S., M.W.S., *&c.*

Having been requested to ascertain the names of several fossil Ancillariæ, brought from the neighbourhood of Grignon, and finding some difficulty in recognising other recent species mentioned by modern writers, I have been led to a general examination of the genus. The result of my observations is contained in the following paper, in which I shall endeavour clearly to define the four recent species mentioned by Lamarck, uniting to them others which are either altogether new, or placed under analogous genera.

The extention of the genus which I shall thus propose, will not, however, require any material alteration in its characters, as defined by M. Lamarck, in the *Animaux sans Vertebres,* tom. 7, p. 412.

In determining the species, I have been principally guided by the number, proportion, and mode of sculpture observed in the lines or grooves, and by the transverse callous belts, which encircle the base of all the Ancillariæ; this latter character likewise be-

longs to Oliva, and its modifications will be found very essential in the discrimination of species; the relative length of the spire will also afford a useful auxiliary character, although it is compaparative, and, in some instances, variable. M. Lamarck, on the contrary, has attempted to draw specific distinctions from the striated base of the columella, but this, as being common to nearly all the species, becomes *generic.* It is, probably, to this cause, and the bad figures that have been given for the species, that we must attribute the mistakes of those who have written upon the subject.

With these preliminary observations, I shall proceed to detail the characters of the genus, and its affinity to others; offering such further remarks as appear necessary, under the respective species to which they more immediately belong.

ANCILLARIA.

Ancilla vel Ancillaria, Eburna—Lamarck.
Ancillus—De Montfort. Ancilla—Sowerby.

Testa oblonga, sub-cylindrica, nitida. Spira plerumque brevis ad suturas non canaliculata. Apertura longitudinalis, basi vix emarginatâ, effusâ. Varix callosus et obliquè striatus ad basin columellæ positus. Epidermide caret.

Shell oblong, sub-cylindrical, polished. Spire in general short, the suture not channelled. Aperture longitudinal, base slightly emarginate. Base of the columella with a thickened, oblique, striated varix. Epidermis none.

SECTIONS.

I. Shell imperforate, varix distinctly striated.

* Spire short.

** Spire produced.

II. Shell umbilicated; varix obsoletely striated.

It appears that M. Lamarck first gave this genus the name of *Ancilla,* which he subsequently changed to *Ancillaria;* this perhaps was unnecessary, yet as this last name is used in all his later and more popular works, I can see no advantage in not adopting it. The *Ancillariæ* are marine; and although the recent species appear confined to the tropical latitudes of the Indian Ocean, several

others abound in a fossil state, in the London clay; at Grignon, Courtagnon, and the environs of Paris *. The genus is founded alone upon the external characters of the shell; no knowledge having yet been acquired of its animal inhabitant. Yet from the close resemblance between the shells of the *Ancillariæ* and the *Olivæ*, we have every reason to suppose they will follow each other in natural affinity, (along with the *Volutæ* and other kindred groups,) among the *Gasteropoda Pectinibranchi* of M. Cuvier. The natural situation of all these shells, however, is very uncertain, and must be determined by the comparative anatomist rather than by the conchologist, who should labour to render his study easy and useful to the more important views of the geologist, and not burthen it by long details on the structure of animals which it may never be in the power of the student to see. I shall make some further observations on this subject in another place.

The shells of the *Ancillariæ* are covered by a finely-polished coating of enamel; from which circumstance we have every reason to conclude that the mantle of the animal (as in *Cypræa*, some *Volutæ*, and other naturally-polished shells) is so much dilated, as to fold over the sides, or even envelop the shell; wherever this is the case it generally happens that the animal is destitute of an operculum, and the shell of any epidermis; both of which, in fact, would be useless. This remark I should wish the reader to bear in mind, as I shall have occasion to revert to it hereafter.

Ancillaria is known from *Oliva* by the suture being either quite concealed, or (as in *A. marginata*) but slightly covered by a coat of enamel; whereas, in *Oliva*, it is open, and remarkably channelled. The thickened and striated base of the pillar is another, but not an exclusive distinction; as a similar structure will be found in many of the African and South American *Olivæ*.

The comparative length of the spire, as in most other genera, is subject to some variation in the species, though to very little in the individuals. I have therefore made use of this as a sectional cha-

* Bowdich, *Conch.* Part I. p. 38.

racter, arranging the species according to its progressive developement, and by this method the transition from one division to the other will be more natural.

SECTION I. ANCILLARIA. *Auctorum.*

* *Spire short.*

1. ANCILLARIA *candida.* Lam.

A. testâ oblongâ, sub-cylindricâ, albâ, effusâ; basi bicinctâ; labii margine lævi.

Shell oblong, semicylindrical, white, effuse; base two-belted; margin of the lip smooth.

A. testâ elongatâ, semi-cylindricâ, candidâ, suturis anfractuum obsoletis; varice columellari substriato. Lam. An. sans Vert. 7, p. 414.

Martini. 2 tab. 65. f. 722. Ency. Méth. pl. 393, f. 6.

Voluta ampla. Gmelin Sys. Nat. 3467.

Bulla ampla. Dillwyn 1. 490.

Ancillaria candida. Lamarck. Monograph in Ann. du Mus. vol. xvi, p. 304. Id. Hist. des Anim. sans Vert. l. c.

Shell from an inch to an inch and a quarter long; lengthened, slender, and semi-cylindrical; the aperture is very effuse, and the spire slender and much shorter than in any of the following species: on the lower half of the basal whorl are two oblique indented lines, parallel and near to each other, which divide the shell (when viewed beneath) into two equal parts; the upper line is more strongly impressed than the lower, and is margined within by another very fine line, which in old specimens is generally hid by enamel; the belt (by being thus divided) may be said to be double, and is scarcely elevated. The whole shell is either pure white, or slightly tinged with yellowish, and sometimes tipt with bright rufous. The figures to which I have referred are very indifferent. Inhabits the Indian Ocean.

2. ANCILLARIA *effusa.* Sp. Nov. Mihi.

A. testâ oblongâ, semi-cylindricâ, fulvo alboque fasciatâ, sulco supra varicem profundo; labio exteriore recto, unidentato; aperturâ fuscâ, effusâ.

Shell oblong, sub-cylindrical, fulvous, with white bands; above the varix of the pillar a deep groove; outer lip straight, one-toothed; aperture brown, effuse.

In general appearance this new species is closely allied to *A. candida,* in its slender and semi-cylindrical shape, and in the wideness of the basal part of the aperture; like that, also, it has a deep sulcated groove, which margins the upper part of the varix, and the belts and sculpure in both are the same; but here the similarity ceases, for (still carrying on the comparison) this shell has a smaller aperture, and a shorter varix; and the outer lip, instead of being smooth, has a mucronate projecting tooth; the colour of the shell is fulvous, with a white band round the suture; the varix is also white, but the aperture brown. The slenderness of its shape, and the effuse form of the aperture, at once distinguish it from all the following species. Length $\frac{17}{20}$ of an inch.

Inhabits —— Mus. nos.

3. Ancillaria *albifasciata.* Sp. Nov. Mihi.

A. testâ oblongâ, fulvâ; spiræ basi albifasciatâ; columellæ basi brevi, valdè obliquâ; labio externo unidentato.

Shell oblong, fulvous; base of the spire with a white band; base of the pillar short, very oblique; outer lip one-toothed.

Shell scarcely an inch long, of an oval oblong shape, and bright buff-coloured yellow, having a white band on the body whorl, or at the base of the spire; the columella is also white, and the base is short, much thickened, and takes a more oblique direction than in the next species; the belts are double, each margined by two parallel impressed lines, the upper of which terminates in a projecting obtuse tooth at the base of the outer lip. In old specimens the lines of growth will sometimes form elevated striæ, which might lead students to believe that such shells belonged to a different species.

Ancillaria albifasciata has probably been overlooked, as a variety of the following species, from which, however, it may be known by its much smaller size, by the aperture being more effuse, and the columella shorter, thicker, and more oblique; by being yellow, instead of deep chestnut, and by not having the two basal lines followed by white bands. Mrs. Mawe has received this species from the East Indies.

4. Ancillaria *cinnamomea.* Lam.

A. testâ oblongâ, sub-cylindricâ, castaneâ; basi albifasciatâ; labio exteriore unidentato.

Shell oblong, sub-cylindrical chestnut; base with a white band; outer lip one-toothed.

A. cinnamomea? A. testâ oblongâ, ventricoso-cylindricâ, castaneo-fulvâ; anfractibus supernê albido-fasciatis; varice columellari rufo, substriato. Lamarck, Anim. sans Vert. 7, 413.

A. cinnamomea? *A. oblonga, ventricoso-cylindrica, castanea; anfractibus supernè albido fasciatis; varice columellari substriato.* Lamarck Annal: du Mus. vol. 16, p. 304.

Martini et Chemnitz, 10. tab. 147 f. 1381. *malè.* Ency. Méth. pl. 393. f. 8?

Ancilla marginata. Sow. Genera, fig. 1, *optimê.*

Ancillaria cinnamomea. Bowdich, Elem. Conch. pl. 10. fig. 10. *malê.*

Shell, one inch one-seventh in length, of which the spire occupies three-tenths of an inch; shape oblong, somewhat cylindrical. The spire being longer in proportion than in the last species, gives this a more pointed appearance. The ground colour is pale cinnamon or fulvous chestnut, darkest round the suture and at the base; having, at both these extremities, one or two narrow bands of white; the upper band, (at the base of the spire) is sometimes obsolete, but the lower ones follow the course of two indented lines which border the double belts, as in the last species; the upper of these lines terminates in a mucronate tooth on the outer lip; the pillar is pure white, occupies one half of the length of the aperture, is longer, and much less oblique than in the last. Here the real difference between the two species will be seen; for the white bands in *cinnamomea* are often variable, and can, therefore, only be taken as an auxiliary character.

Inhabits Ceylon and other parts of the Indian Ocean. This, although a distinct species, has been little understood; and the contradiction between the descriptions of Lamarck, and the figures which he has quoted, renders it impossible to decide with precision which is the true *cinnamomea.* In both his descriptions, Lamarck says, the varix ofthe pillar is " *roussâtre.*" He adds further, " on voit *un sillon* dorsal transverse et très oblique vers la partie inférieure du dernier;" (Syst. 7, p. 413.) but our species has *two.*

In the first description of *cinnamomea*, he refers to Martini, 2 tab. 65. f. 731; but in his next, he transfers this reference without any explanatory notice, to *A. ventricosa*. This last figure of Martini seems to me too ambiguous to admit of being cited for either *cinnamomea* or *ventricosa*.

On the whole, it must either be supposed, that Lamarck's *cinnamomea* is a distinct species, having a coloured varix, a single basel groove, and a smooth margin to the lip, (the two first characters not appearing in any of the figures he cites,) or that he has incorrectly described the shell figured by Martini (f. 1381.) The latter supposition is most probable; and I therefore propose to consider this figure as representing the true *cinnamomea*.

M. Sowerby represents the same shell as Martini, (f. 1381), supposing it the *marginata* of Lamarck. That, however, is a very distinct species, with an elongated spire, and comes under our next division.

5. Ancillaria *fulva*. Sp. Nov. Mihi.

A. testâ ovatâ, fulvâ, aut rufâ; basi balteo simplici cinctâ; labio exteriore lævi; varice columellari sub-bistriato.

Shell ovate, fulvous; base with a single belt; outer lip smooth; varix of the pillar with two striæ.

Size of *variegata*; but is much less ventricose, and the base more oblique; its form is oval, and more swelled than any of the preceding species; its spire also is more produced and pointed, and is half the length of the aperture; the varix is small, white, and has only two grooves or striæ, the lower of which is very faint; the base has only a single belt, and the margin of the outer lip is quite smooth. The whole shell is either of a uniform orange yellow, or cinnamon colour, with the point of the spire white. Habitat——Mus. nost.

6. Ancillaria *variegata*. Sp. Nov. Mihi.

A. testâ ovato-ventricosâ, albescente, fasciis castaneis variâ; basi balteo simplici cinctâ; labio exteriore lævi; varice columellari bistriato.

Shell ovate-ventricose, whitish, variegated by chestnut bands; base a single belt; outer lip smooth; varix of the pillar bistriated.

Size of the last; but is much more ventricose, and the pillar

more distinctly striated. The ground-colour of the shell is whitish, delicately banded by different shades of pale chestnut or cinnamon; which are sometimes interrupted, longitudinally, by others nearly white.

Inhabits the East Indies, and is rather an uncommon shell: may it not prove to be a variety of *A. fulva*? Mus. Broderip. Nost.

7. ANCILLARIA *ventricosa.* Lam.

A. testâ ovatâ, ventricosâ, castaneâ; basi obliquè bisulcatâ; labio exteriore ad basin crenato, unidentato.

Shell ovate, ventricose, chestnut; base with two oblique grooves; outer lip at the base crenated, and one-toothed.

Ancillaria ventricosa. *A. ovata, ventricosa, aurantio-fulva; varice columellari albo, læviusculo.* Lamarck, Ann. du Mus. vol. xvi, p. 304. A. ventricosa. *A. testâ ovatâ, ventricosâ, aurantio-fulvâ; spirâ apice obtusiusculâ; varice columellari albo, læviusculo.* Lamarck, Hist. Anim. sans Vert. 7, p. 413.

A. cinnamomea. Journal of the Royal Institution, vol. xvi. plate 5, f. 206.

Shell, one inch and a third long, of which the spire occupies nearly half an inch. Its form is oval, and more ventricose than any of the preceding species; its spire is not so thick as the last, but is longer and more slender; the tip, also, is more obtuse; the whole shell is highly polished, and is of a uniform dark chestnut colour, excepting the pillar, which is white. At the base, is a broad elevated belt, margined above by a deep groove; parallel to which, (but within the belt,) is another groove less distinctly marked. The upper groove forms a mucronate tooth on the margin of the outer lip; having on each side, two or three slight crenulations: the tip of the spire is white.

A. ventricosa is known from all the foregoing species by the length of its spire: it is more particularly distinguished from *cinnamomea*, by being shorter and more ventricose, by the pillar being less striated, and by the crenated base of the outer lip. Moreover, an acute observer will detect in this shell, the rudiments of the two additional grooves which margin the upper part of the belt in all the species of the next division.

Inhabits the Indian ocean. It is an uncommon shell, and is here described from a beautiful specimen in Mr. Broderip's cabinet.

This, I have no doubt, is the true *ventricosa* of Lamarck: for, as far as his description goes, it is very correct. With regard to the figures which he has cited, it is clear that no reliance can be placed on that of Martini, 2 tab. 65, f. 731; for Lamarck has quoted this same figure twice, for two different shells. Lister's (tab. 746) is as badly defined, and both are among those, which no accurate writer should venture to cite, as an authority for any particular species. The best, and indeed the only tolerable representation of this shell that I have met with, is to be found in this Journal, vol. xvi, plate 5, f. 206 *, and does great credit to the talents of the lady who designed it: the crenated lip will only be observed in very perfect and adult specimens.

** *Spire produced.*

The few species included in this group, form a natural and beautiful passage, by which the imperforate and perforate sections are united. The spire here occupies one-half of the total length of the shell; or, in other words, is as long as the aperture. In all the species, there is a thickened belt of enamel, which margins the suture of the body whorl, and in the recent species, there is a third belt at the base, which is very narrow, and composed of two indented parallel lines, terminating in obtuse teeth on the margin of the lip; this character likewise belongs to the perforate species.

8. ANCILLARIA *marginata*. Lam.

A. testâ ovatâ, ventricosâ, albente, suturâ carinatâ, fusco-maculatâ; aperturæ spiræque longitudine æquali.

Shell ovate, ventricose, whitish, suture spotted with brown, and carinated; aperture and spire of equal length.

A. Marginata. *A. ovata, ventricosa, albida; spirâ acutâ, carinulatâ, interruptè fasciatâ; labro basi unidentato.* Lamarck, Ann. du Mus. xvi, p. 304.

A. Marginata. *A. testâ ovatâ, ventricosâ, albidâ; spirâ exserto-acutâ, carinulatâ; anfractibus supernè maculis rufis seriatim marginatis; aperturâ basi emarginatâ; callo columellari angusto, striato.* Lamarck, Hist. Anim. sans Vert. 7, 413, No. 3. Ency. Méth. pl. 393, fig. 2. a. b.

* It is there called, by mistake, *A. cinnamomea.*

Shell, one inch and three-quarters long; oval, ventricose, and somewhat fusiform, the spire being pointed, and nearly of the same length with the aperture; the base is also contracted. The suture is marked by a slender, obtuse, carinated line: the body whorl is flesh-coloured, and finely striated longitudinally; having on the upper part a slightly-thickened belt, margined below by an impressed line; the belt is continued on the spiral whorls, and is marked by brown spots or blotches. At the base of the shell are two thick belts, also brown; above which are two parallel grooves, forming *two* teeth at the base of the outer lip, and not *one*, as mentioned by Lamarck. The inside of the aperture is orange-brown: the varix on the pillar slender, and deeply striated; and the base considerably emarginated.

9. Ancillaria *subulata*, Lam.

A. testâ ovatâ, subfusiformi, basi bicinctâ, spirâ productâ, acutâ; labio exteriore lævi.

Shell ovate, subfusiform, base with two belts, spire lengthened, acute; outer lip smooth.

Var. 1. *Spire and aperture of equal length.*

A. buccinoides. A. ovato-acuta, ad spiram basimque margaritacea; callo columellæ striato.

Lamarck, Ann. du Mus. 16. 305. 2. Id. Hist. Anim. sans Vert. 7. 414.

Lamarck, Planches Coq. Foss. pl. 2. f. 5. a. b. *malè.*

Ency. Méth. 393. f. 1. a. b.

Ancillus buccinoides, D. de Montf. 2. pl. 382.

Var. 2. *Spire longer than the aperture.*

A. subulata. A. subturrita lævigata, nitida, spirâ elongatâ subulatâ; fasciis transversis suturalibus; callo columellæ striato. Lam. Ann. du Mus. 16. 305. 3. Id. Hist. Anim. sans Vert. 7. 415. 3.

Lister, 1034. f. 8.

Ency. Méth. 393. f. 5. a. b.

Ancilla subulata, Sowerby's Genera, f. 2. 2. *optimè.*

Fossil of Grignon and Hordwell?

Shell from one inch and a quarter to two inches in length: the spire is long, and acutely pointed; but subject to considerable

variation in its length, sometimes being shorter than the aperture, sometimes of equal length, and in other specimens considerably longer. The following characters, however, belong equally to all these varieties. The spire is covered by a thick coating of enamel, which unites to a transverse, marginated band of the same, on the upper parts of the body whorl. At the base are two oblique, marginated, and thickened belts; the varix of the pillar is strait and deeply striated; the aperture moderately effuse, and the margin of the outer lip entire.

The distinction which M. Lamarck has made between his *A. buccinoides* and *subulata*, rests entirely on the relative length of their spires; while on their sculpture he is entirely silent. He refers to the figures in the Ency. Méth. (tab. 393. 1 and 5.) for both, and were we to judge alone from these, (which are tolerably correct,) we should certainly be inclined to believe they represented two distinct species; but a series of specimens now before me, by the progressive developement of the spire, unites the two extremes of length so completely, that I feel persuaded they are varieties of one species. This transition, indeed, may be seen by consulting the following authors, in the series here set down. Ency. Méth. 393. 1. Sowerby, Ancilla, f. 2. Lister, 1034, 8. Ency. Méth. 393. f. 5. The references made by Lamarck to Knorr, 2. tab. 43. f, 18. I have no means at present of consulting.

10. Ancillaria *obtusa*. Sp. Nov. Mihi.

A testâ ovatâ flavescente, infrà rufâ; spirâ bevi, crassâ, obtusâ, castaneâ; striis columellæ obsoletis.

Shell ovate, yellowish, beneath rufous; spire short, thick, obtuse, chestnut; striæ on the pillar obsolete.

This is a recent species, hitherto undescribed, and so closely does it resemble the figure of *A. glandiformis*, given at pl. 393. f. 7. of the *Ency. Méth.* that it might be almost assimilated to that shell, but for the danger of uniting recent and fossil species without very minute examination; this I am at present unable to do, not having a specimen of *Glandiformis* in my own collection.

The spire of the *A. obtusa* is little more than half the length of the aperture, and is rendered very thick and almost shapeless, by a

coating of enamel, which also forms a mass on the upper angle of the aperture; this enamel is likewise continued as a belt across the shoulder of the body whorl; the base of the shell has two thickened belts; the upper of which is chestnut, and margined above by a narrow white band, in which are two slender grooved lines; the middle of the body whorl is pale yellowish above, and deep chestnut beneath; the shoulder belt and the spire are also chestnut, with two white bands; the tip of the spire, the aperture, and the callosity above it, are pure white; base of the pillar but slightly thickened, and faintly striated by two grooves; outer lip one-toothed. This rare species is probably found at the Cape of Good Hope. Two specimens were in the African Museum, and are now in the cabinet of Mr. Broderip.

11. ANCILLARIA *Tankervillii.* Sp. Nov. Mihi.

A. testâ imperforatâ, oblongâ, flavescente; spirâ elongatâ, lineâ juxta suturam levatâ: basi sulcatâ.

Shell imperforate, oblong, yellowish; spire elongated, with an elevated line near the suture; base grooved.

A single specimen of this exceedingly rare shell exists in the Tankerville collection; from which the above specific character was hastily noted down, while inspecting that magnificent cabinet last year. In size and proportions it perfectly resembles the *Ancillaria glabrata* (Buccinum glabratum, *Lin.*) yet, like the next species, has not the least vestige of an umbilicus. It is clearly distinguished from *A. rubiginosa* by the elevated line which follows the suture. We may expect the imperfections of this description to be soon supplied by Mr. G. Sowerby, in the catalogue of this noble collection, now preparing for publication.

12. ANCILLARIA *rubiginosa.* Sp. Nov. Mihi.

A. testâ imperforatâ, oblongâ, castaneâ, spirâ elongatâ; anfractu basali balteato; basi bicinctâ, sulco concavo insigni.

Shell imperforate, oblong, chestnut; spire elongated; body whorl above banded; base with two belts, and a concave groove. *A. rubiginosa,* Sw. in Philos. Magazine 62, p. 403. Ancillaria, pl. 1. Sw. Illus. of Zoology ined.

In size, shape, and in the proportion of its spire, this beautiful species resembles *A. Tankervillii* and *glabrata*. It is two inches and three-quarters in length, one half of which is occupied by the spire. In the thickened belts, and the concave grooves above them, it resembles *A. glabrata ;* but the enamel which covers the spire forms an additional belt on the shoulder of the body whorl; the pillar is nearly smooth, completely imperforate, and flesh-coloured white; the concave groove is rather wide, containing two impressed lines, and forms a tooth at the margin of the outer lip. The general colour of the whole shell is a rich dark chestnut and highly polished.

A magnificent specimen of this fine shell is in the possession of my friend Mr. Broderip. It came from China, and has been engraved for " Illustrations of Zoology," now preparing for publication.

The discovery of the two last shells unites the *Ancillariæ,* in the most beautiful manner, to the *Eburna glabrata* of Lamarck : before they were known, this affinity appeared to me so strong that I purposely refrained from associating this last-named shell with the other Lamarckian *Eburnæ*. (See Zool. Ill. vol. 3. pl. 144.) Thus the imperforate and the umbilicated species are connected; and, if this connexion could be rendered more perfect, it would be by a species wherein the umbilicus is only partially developed. Now it is very remarkable that such a structure will actually be observed in the following species :—

2. Shell umbilicated.

13. Ancillaria, *balteata.* Mihi.

A testâ subumbilicatâ, ovatâ ; anfractûs basalis parte superiore balteo gibbo convexo cinctâ.

Shell sub-umbilicated, ovate, upper part of the basal whorl with a gibbous convex belt.

Eburna balteata, *testâ cylindraceo-oblongâ, spirâ sub-conicâ, anfractu ultimo supernè incrassato ; infernè balteato.* Sowerby, Genera, Fasc. 19. pl. Eburna, f. 3, 4, *optimè.*

This is a small species, scarcely ever exceeding one inch and a quarter in length, half of which is occupied by the spire. Its shape is thicker in proportion than that of *A. glabrata ;* the upper part of the

body whorl is crossed by a very thick convex belt of whitish enamel, which likewise spreads over the spire. The umbilicus is placed in the same part of the shell as in *A. glabrata,* but is only partially developed, being represented by a deep sulcation, instead of the hollow space (between the inner lip and the body whorl) seen in the two following species. The basal belts are four; two are convex, of which the upper one is narrow; then follow two grooved lines; and above all these, and nearly in the middle of the body whorl is another broad belt of thin enamel; this additional belt is also in the next species, but is not seen in *A. glabrata.* On the whole, it appears that the specific character of *balteata* must rest on the thick convex margin of the body whorl, and the imperfect form of the umbilicus.

Mr. Sowerby has given an excellent figure of this species, and associates it very properly with the *Eburna glabrata* of Lamarck. I am told by Mr. Mawe that it has been brought from the Red Sea.

14. Ancillaria *nivea.* Sp. Nov. Mihi.

A. testâ umbilicatâ, ovato-oblongâ, albâ; anfractibus supernè crassioribus; basi tricinctâ, balteis lineis 2, impressis, divisis.

Shell umbilicated, ovate-oblong, white; whorls above thickened; base with three belts, divided by two impressed lines.

Shell one inch and three-quarters long, larger and more oblong than the last, and of a pure white, highly polished; the upper part of all the volutions is slightly thickened, and it has the same number of belts as *balteata,* but with this difference, that, in *Nivea,* the two lowermost are of equal breadth, and deeply divided; but in *balteata* the upper one is very narrow, and the division slight; the umbilicus moreover is as large as in the next species.

15. Ancillaria *glabrata.* Mihi.

A testâ umbilicatâ, ovato-oblongâ, fulvâ, anfractibus lævibus; basi bicinctâ, balteis sulco supernè marginatis.

Shell umbilicated, ovate oblong, fulvous yellow, whorls smooth, base with two belts, margined above by a sulcated groove.

Buccinum glabratum. Linn. Gm. 3489. Brug. Dict. 264. 28.

Eburna glabrata. Lam. Anim. sans Vert. 7, p. 281. Sow. Gen. Fasc, 19. Eburna f. 1.

Icones. Lister, 974. f. 29. Gualt. tab. 43. f. T. Knorr. 2 tab. 16. f. 4. 5 Martini, 4 tab. 122. f. 1117. Ency. Méth. pl. 401. f. a. b. Sow. Genera. b. c.

This common shell has been so often described, either as a Buccinum or an Eburna, that a detailed account of it is here unnecessary. Its size, shape, and proportions are those of *A. Tankervillii* and *rubiginosa,* from which it differs in being umbilicated: the base has two thick and nearly equal belts, the upper one margined by a deep groove, wherein are two impressed lines, but it wants the additional belt, which surmounts these lines, in *balteata* and *nivea.* Like all the other *ancillariæ,* having a grooved base, there is a mucronate tooth on the edge of the outer lip. Inhabits the Indian Ocean.

M. Lamarck, it is well known, has placed this shell among his *Eburnæ,* probably on account of its being umbilicated; for it appears that no writer is, as yet, acquainted with its inhabitant. The propriety of this arrangement has been questioned by others, and is, I think, proved erroneous, by the fact of the other *Eburnæ* being naturally covered by an epidermis; a presumptive proof that their animals are formed on a very different construction to that of *Ancillaria glabrata,* which is a naturally polished shell, and consequently either wholly, or in part, covered by the dilated mantle of its inhabitant. Its relation to the *Eburnæ* is therefore more that of analogy than of affinity.

On the other hand, setting aside the very obvious similarity of *habit* between *A. glabrata,* and the Lamarckian *Ancillariæ,* the discovery of the new species here described, unites them so gradually and so naturally, that no other character can be used to separate them generically, than that some are imperforate and others are not. The very little importance that belongs to the umbilicus is generally known; for we see its presence or absence in different growths of the same shell; it cannot, therefore, have much to do with the structure of the animal. Still less can an umbilicus constitute a type of form; or, in other words, a genus.

Admitting, therefore, that *A. glabrata* belongs not to the La-

marckian *Eburnæ*, but is now proved to be intimately united with *Ancillaria*, the next question is, what are we to do with the other Lamarckian *Eburnæ?* Should we not leave them undisturbed in the genus *Eburna?* Undoubtedly. For it is a rule universally acted upon in zoological nomenclature, that when a species or genus is dissevered from another, the original generic name is continued to those species that are left; while those that are taken away, are either placed under other genera, or form a new one of themselves. It would be idle to adduce proofs in support of this argument; the difficulty would be, to find a case where this rule has *not* been acted upon.

The fit application of the name of *Eburna*, to those shells which will now remain in the genus, is a matter of very secondary importance; nomenclature is no branch of natural history, and the science has already been deeply injured by the fancied consequence which has been attached to it. The specific names of *balteata* and *nivea* may with equal reason be objected to; because all the *Ancillariæ* are belted, and there is more than one species purely white.

To the species which I have now described, must be added the following, which have been found in a fossil state in France, and are described by Lamarck, viz.—*A. glandiformis*, *olivula*, and *canalifera*; neither of these I have hitherto seen. The total number of species contained in the *Hist. Nat. des Animaux sans Vertèbres* amounts to four recent, and five fossil. The recent species are now augmented to fourteen, and the fossil reduced to four, making altogether an accession of nine species.

Synopsis.

ANCILLARIA.

SYNOPSIS.

Testa Imperforata.	Spira brevis.		Oblonga, candida; aperturâ valdè effusâ; labio lævi	1. *Candida.*
			Oblonga fulvo alboque fasciata; aperturâ effusâ; labio unidentato	2. *Effusa.*
			Ovata, fulva; varice brevi, valdè obliquo; labio unidentato	3. *Albifasciata.*
			Oblongo-ovata, cinnamomea; basi albifasciata; labio unidentato	4. *Cinnamomea.*
			Ovata, fulva, vel rufa; basi unicincta; labio lævi	5. *Fulva.*
			Ovato-ventricosa, albescens, fasciis cinnamomeis; basi unicincta; labio lævi	6. *Variegata.*
			Ovato-ventricosa, castanea; basi cinctâ et bisulcatâ; labio crenato	7. *Ventricosa.*
	Spira producta.	Varix striatus	Oblongo-ventricosa, spirâ acutâ; suturis carinatis; labio dentato	8. *Marginata.*
			Ovato-oblonga, spirâ elongatâ, acutâ; basi bicinctâ; labio lævi	9. *Subulata.*
			Basi sulcatâ labioque dentato.	
		Varix tantùm non lævis.	Ovata; spirâ crassâ, valdè obtusâ	10. *Obtusa.*
			Oblonga, flavescens; suturæ lineâ marginali levatâ	11. *Tankervillii.*
			Oblonga, castanea; anfractu basali supernè cincto	12. *Rubiginosa.*
Testa perforata.			Flavescens, umbilico obsoleto; suturâ balteo gibbo supercinctâ	13. *Balteata.*
			Alba, umbilico aperto; basi tricinctâ	14. *Nivea.*
			Flava, umbilico aperto; basi bicinctâ	15. *Glabrata.*

ANCILLARIA.

SYNOPSIS OF THE SPECIES.

Shell imperforate.	Spire short.		Oblong, white, aperture very effuse, lip smooth	1. *Candida.*
			Oblonga fulvous, aperture effuse, lip one-toothed	2. *Effusa.*
			Ovate, yellow; varix short, very oblique; lip one-toothed	3. *Albifasciata.*
			Oblong ovate, cinnamon, base with a white band, lip one-toothed	4. *Cinnamomea.*
			Ovate, yellow, base with a single belt, lip smooth	5. *Fulva.*
			Ovate-ventricose, with cinnamon bands, base belted, lip smooth	6. *Variegata.*
			Ovate-ventricose, chestnut, base belted, and two-grooved, lip crenated	7. *Ventricosa.*
	Spire lengthened	Varix triated	Oblong-ventricose, spire pointed, sutures carinated, lip toothed	8. *Marginata.*
			Ovate-oblong, spire lengthened, acute, base with two belts, lip smooth	9. *Subulata.*
			WITH A SULCATED GROOVE AND TOOTHED LIP.	
		Varix nearly smooth	Ovate; spire thick, very obtuse	10. *Obtusa.*
			Oblong, yellowish, suture with an elevated marginal line	11. *Tankervillii.*
			Oblong, chestnut, upper part of the body whorl belted	12. *Rubiginosa.*
Shell perforate.			Yellowish, umbilicus obsolete, suture with a gibbous belt	13. *Balteata.*
			White, umbilicus open, base with three belts	14. *Nivea.*
			Yellow, umbilicus open, base with two belts	15. *Glabrata.*

Art. VI.—*A Letter from* Sir Everard Home, Bart., *respecting a Statement published by* Doctor Bostock *in his Elements of Physiology.*

To the Editor of the Quarterly Journal of Science.

My dear Sir,

May I request that you will insert in your Journal the following Notice and extract from my Lectures, that all those who have been misled by the assertion, may be better informed.

NOTICE.

Dr. Bostock, in the first volume of an Elementary System of Physiology, p. 234, states, that Sir Everard Home regards the gelatinous substance in the brain as the very essence of life; and in a note, says, "Sir Everard has broached the most direct system of materialism that has been given to the world."

Sir Everard Home begs to assure Dr. Bostock in this public manner, that the expression *essence of life* is not met with in any part of his works. That he is not either a materialist or a craniologist; that he has a full conviction in the being of an all-wise God, to whom he looks up for mercy, and in whom he puts his trust.

Sir E.'s expression is *materia vitæ,* by which he did not mean that such matter was the essence of life, but the first matter on which the vital principle is exerted.

Extract from Lectures on Comparative Anatomy, vol. iii, *page* 42.

On the Brain and Nerves.

As the transparent mucus is not only one of the most abundant materials of which the brain itself is composed, but is the medium by which the globules of the retina are kept together, and serves the same purpose in the medullary texture of the nerves, there can be no doubt that the communication of sensation and volition more or less depends upon it. And it would appear from the following case, that when terminations of nerves are covered with this mucus, it partakes of their sensibility.

A lady had a wound on the breast in a healing state; a prominent speck of a black colour suddenly made its appearance on the surface, it was tender beyond expression to the touch. Next day it disappeared, and the tenderness was gone. The speck must have been this jelly coagulated upon the termination of a nerve, and therefore the impression made by touching it was communicated to the nerve; but when it was absorbed, the nerve received a coating of coagulable lymph, and there was no more pain.

Mr. Hunter's comprehensive mind grasped at the idea of the existence of something of this kind, although he had not arrived at a knowledge of the substance employed to produce the effect. He said, that so wonderful was the connexion between the brain and every structure of the body, that it was to be explained in no other way, than by considering that the *materia vitæ* was every where in one of two forms; collected into one mass in the brain, which he called *coacervata;* and diffused through the body, which he called *diffusa;* and the nerves communicated between them.

From Mr. Bauer's microscopical examinations of the medullary structure of the brain, the variety in the size of the globules, and in the consistence of the uniting medium, it becomes evident that very different functions are performed by these various structures.

Art. VII.—*Facts towards the Chemical History of Mercury.*

§ I. *Of the Oxides of Mercury.*

Some valuable information respecting the oxides and sulphurets of Mercury has been published by M. Guibourt, in the *Journal de Pharmacie*, of the year 1816; but we cannot agree with his conclusion as to the impossibility of obtaining an insulated protoxide, and an insulated protosulphuret of that metal; at least, if we understand him rightly, he considers those compounds as mixtures of metallic mercury with the peroxide and bisulphuret respectively, and this, because they are so easily resolved by heat, and even by trituration, into running mercury and peroxide, and running mercury and bisulphuret. But we do not reject iodide of nitrogen, or fulminating

silver or mercury from the list of chemical compounds, because slight mechanical means suffice to decompose them.

Calomel boiled in excess of solution of soda, or treated with excess of ammonia, yields a black powder, which, if carefully dried out of the contact of air, affords, on decomposition, about ninety-six per cent. of mercury, and four of oxygen; or 200 of mercury and *eight* of oxygen; while the red oxide of mercury, a crystalline, permanent and definite compound beyond all doubt, affords 200 of mercury and *sixteen* of oxygen. There is, therefore, every reason for adopting the former as a true combination, for we find that it is entirely soluble in and forms distinct salts with acids, and that it contains just half the proportion of oxygen existing in the peroxide. It is nevertheless true, that by a gentle heat, by trituration, or by exposure to light, this protoxide throws off a portion of its mercury, whilst the remainder of the metal passes into the state of peroxide.

§ II. *Of the Sulphurets of Mercury.*

In respect to the sulphurets of mercury, M. Guibourt is of opinion that the protosulphuret is to be considered as a mixture *(un mélange)* of cinnabar and metallic mercury, because it is as easily decomposed as the protoxide; nevertheless he shows that it consists of 200 of mercury and *sixteen* of sulphur, and that the bisulphuret, or cinnabar, is composed of 200 mercury and *thirty-two* sulphur: there seems, therefore, no reason whatever for assuming the protosulphuret to be an indefinite mixture; and if it be considered, as some would have it, a *compound* of cinnabar and mercury, what is that but a protosulphuret, as proved by its analysis? Respecting the mode of obtaining the protosulphuret, there may, however, be some difference of opinion. It appears to us that the only method by which such a definite compound can be procured, consists in passing sulphuretted hydrogen gas into a very dilute solution of the protonitrate of mercury, or into water through which calomel is diffused; in either case, a perfectly black precipitate is formed, which, when collected upon a filter, and very carefully dried, exhibits no globules of mercury, and which, when analyzed, affords results

consistent with one proportional of mercury and *one* of sulphur. Like the protoxide, however, it is singularly easy of decomposition. Trituration effects this, so does exposure to the sun's rays, so does a heat of 300° ; and when heated in a glass tube in the flame of a spirit lamp, mercury distils over, and bisulphuret is sublimed.

The pharmaceutical preparation, called *Ethiops-mineral*, is generally stated to be a mixture of sulphur and black sulphuret of mercury; indeed it is called, in the latest edition of the London Pharmacopœia "Hydrargyri Sulphuretum Nigrum." It has long had a place in the materia medica, though a very useless and inert compound. It is a black powder, prepared by triturating together equal weights of mercury and sulphur, until globules are no longer visible. When properly made it may be rubbed upon gold, without leaving any mercurial stain upon that metal; hence it appears that the mercury is in chemical combination with the sulphur, a circumstance indeed sufficiently evident from the great rise of temperature that ensues when the materials are subjected in large quantities to powerful trituration; they then smoke and agglutinate. Fourcroy and several other chemists have regarded this compound as consisting of sulphur and black oxide of mercury; but Prout and others have amply demonstrated the fallacy of such an opinion, without however showing the real nature of the substance. It has lately been usual to describe it as a mixture of sulphur and black, or protosulphuret of mercury; and it is stated in several pharmaceutical works of authority * to be "insoluble in nitric acid, but totally dissolved by a solution of pure potassa." An inquiry into the truth of this assertion, so contrary to what one would expect *à priori,* has, I think led to a satisfactory explanation of the nature of Ethiops-mineral.

A portion of well-prepared Ethiops-mineral was boiled in solution of potassa until no further action took place; the liquor was then decanted off, and fresh portions of the alcaline solution added, the boiling being repeated as before, until no further action ensued.

* Duncan's Edinburgh New Dispensatory. Thomson's London Dispensatory. Paris, Pharmacologia.

There remained a black powder not acted upon by strong solution of potassa, nor by nitric, nor muriatic acid. It was collected upon a filter, thoroughly edulcorated, and dried in a very moderate heat, not at any time exceeding 212°; it was then of a very dark violet hue; when heated in a glass tube it sublimed without any evolution of mercury, and became perfect cinnabar. It appears, therefore, that Ethiops-mineral is far from being soluble without decomposition in alcaline menstrua; on the contrary, solution of potassa merely abstracts its excess of sulphur, furnishing a liquid sulphuretted hydrosulphuret of potassa, from which the acids throw down sulphur, but which affords no traces of mercury. When, however, moist bisulphuret of mercury, as it is left by the alcaline solution, is boiled in a strong solution of hydrosulphuret of potassa, a minute quantity of it appears to be taken up.

There are some discrepancies in the chemical history of the bisulphuret of mercury or cinnabar, as given in the above quoted works, which the following facts may perhaps tend to clear up.

Cinnabar is not altered (except slightly as to colour, which is somewhat brightened whilst it is moist) by long-continued boiling in nitric acid; nor is it affected by muriatic acid under similar circumstances. Nitro-muriatic acid instantly attacks it even in the cold, and by boiling converts it into a persulphate of mercury. If the sulphuric acid be precipitated by muriate of baryta, it is found that eighty parts are obtained from 232 of cinnabar, indicating the existence of two proportionals of sulphur to one of mercury, as above stated *. Sulphuric acid is partially decomposed when boiled upon cinnabar; sulphurous acid gas is given out, and upon boiling down to dryness a white sulphate of mercury is ultimately obtained. The non-action of nitric acid upon cinnabar, considering

* In this analysis of cinnabar it was found that 232 grains of cinnabar, after having been acidified by nitromuriatic acid, required exactly 248 grains of crystallized muriate of baryta for the precipitation of 236 grains of sulphate of baryta. The correctness, therefore, of Mr. Phillips's equivalent for crystallized muriate of baryta may be considered as established, viz., that it consists of 1 proportional of dry muriate (chloride of barium) $= 106 + 2$ proportionals of water $(9 \times 2 = 18) = 124$.

the facility with which it oxidizes and acidifies its elements, is remarkable; and it deserves notice, that when the black protosulphuret of mercury (obtained by precipitation from the protonitrate by sulphuretted hydrogen) is boiled with that acid, that it is speedily decomposed and entirely converted into nitrate of mercury, and not a particle of cinnabar is separated, which probably would be the case if M. Guibourt's view of its composition were correct.

§ III. *Of the Chlorides of Mercury.*

It is now universally admitted, that calomel and corrosive sublimate are chlorides of mercury; that calomel, or the protochloride, consists of one proportional of mercury = 200, and one of chlorine = 36; and that corrosive sublimate, or the perchloride, consists of one proportional of mercury = 200, and two of chlorine = 72: the equivalent or representative number therefore of the former, is 236, and of the latter 272.

In some inquiries connected with the preparation of calomel upon the large scale, conducted in the laboratories at Apothecaries' Hall, Mr. Hennell has discovered several curious and important facts respecting the chlorides of mercury, more especially in relation to the triple compounds formed by corrosive sublimate with other chlorides. He has ascertained that certain chlorides which appear to have no action upon calomel at common temperatures, decompose it at a boiling heat, to a greater or less extent, and resolve it into corrosive sublimate and metallic mercury *.

This action he has particularly investigated in respect to common salt and muriate of ammonia, those being the substances usually employed for the purpose of washing calomel, under the idea of

* Since writing the above, the following note has been received from Mr. Hennell:—

"I had repeatedly noticed a bluish tint which calomel acquires when washed in a boiling solution of muriate of ammonia, as directed by the London Pharmacopœia, to remove corrosive sublimate. To ascertain the cause, I boiled 100 grains of pure calomel in a solution of muriate of ammonia, containing 100 grains of the salt. The change of colour in a few minutes was very evident. The solution, when tested, contained corrosive sublimate. The

freeing it from corrosive sublimate, an effect which they fulfil when employed cold and in dilute solution only. But when perfectly pure calomel is boiled for a few minutes in a solution of muriate of ammonia or of common salt, and a portion of the liquor filtered off and tested, a portion of sublimate is always found in it; and on boiling for a long time, the whole of the calomel is decomposed, and compounds of sal ammoniac and corrosive sublimate, and of common salt and corrosive sublimate, are obtained, an equivalent portion of metallic mercury being at the same time separated.

These facts are peculiarly important in relation to the preparation of calomel, inasmuch as the Pharmacopœia directs the use of a hot solution of muriate of ammonia, with the intention of freeing it from any accidental admixture of corrosive sublimate; and Dr. Henry, in describing the methods of ascertaining the purity of calomel, directs it to be boiled in solution of muriate of ammonia. "When carbonate of potassa," he observes, "is added to the filtered solution, no precipitation will ensue, if the calomel be pure*." Several other chemists of eminence have given this as a criterion by which to recognise the presence of corrosive sublimate in calomel; whereas it appears from Mr. Hennell's experiments, that the protochloride of mercury is in such cases decomposed, and that perchloride is formed.

The compounds of corrosive sublimate with other chlorides, though noticed by many authors, and more particularly by Dr. Davy, in his paper printed in the Philosophical Transactions for the

boiling was continued with four other portions of muriate of ammonia, 100 grains each; when the calomel was entirely decomposed, 40 grains of mercury remained. Sixty grains of white precipitate were obtained from the solutions by carbonate of soda. There was no decomposition of the sal ammoniac. With common salt I obtained the same results, mercury remaining, and white precipitate being thrown down from the solutions, by liquid ammonia. Common salt is not so active in producing these changes; as *ten* portions of 100 grains each were used before the decomposition of 100 grains of calomel was complete. Muriate of potass and the earthy muriates have, I have every reason to believe, the same power; but I did not push the experiments as in the case of soda and ammonia."

* Elements of Experimental Chemistry, 9th Edition, p. 588.

year 1822, have not hitherto been submitted to analysis, nor examined with much precision. Mr. Hennell has already obtained some interesting results upon this subject, of which we hope to be able to give an account on a future occasion. In examining the mutual action of muriate of ammonia and corrosive sublimate, his attention was naturally directed to the substance usually called *white precipitate*, the "Hydragyrum præcipitatum album," of the *Pharmacopœia;* his experiments appear to me to leave little doubt that it consists of one proportional of peroxide of mercury, and one of muriate of ammonia*.

W. T. B.

* Having inferred from previous experiments, that the "white precipitate" was a compound of one proportional of peroxide of mercury and one of muriate of ammonia, Mr. Hennel verified his opinion as follows. A solution of one proportional of corrosive sublimate (= 272) was mixed with a quantity of solution of ammonia, containing two proportionals ($17 \times 2 = 34$) of that alkali; a neutral mixture resulted, white precipitate was formed, and one proportional of muriate of ammonia, (ammonia 17 + muriatic acid 37 = 54 of muriate of ammonia) was found in solution. In this case, the 2 proportionals of chlorine in the sublimate ($36 \times 2 = 72$) were converted, at the expense of 2 proportionals of water, into 2 of muriatic acid, which, uniting with the ammonia, formed 2 of muriate of ammonia. The 2 proportionals of the oxygen from the water (equivalent to the 2 of hydrogen transferred to the chlorine) united to the 1 proportional of mercury in the sublimate, to form 1 of peroxide of mercury, which fell in combination with 1 of muriate of ammonia to constitute white precipitate; while the other proportional of muriate remained as above stated in solution. The equivalent number, therefore, of white precipitate, is 270, and it consists of

1 proportional of peroxide of mercury =	216	80
1 ———— muriate of ammonia =	54	20
	270	100

Having thus synthetically established the composition of white precipitate, the following analytical experiment was made upon it; 270 grains were dissolved in hydrocyanic acid, and sulphuretted hydrogen was passed through the solution till it occasioned no further change; the precipitate was then collected, washed, and dried; it weighed very nearly 232 grains, being the equivalent of bisulphuret of mercury. The filtered liquor, on evaporation to dryness, left 54 grains, or 1 proportional of muriate of ammonia.

ART. VIII.—*Extracts of Letters from* W. J. BANKES, Esq., *containing an Account of* Mr. LINANT's *Expedition to* SENNA'AR, *with a Latin Inscription from* MERÖE.

Soughton-hall, Northop, N. W., Nov. 26, 1824.

MY DEAR SIR,

I have to communicate to you a piece of intelligence, which, I am sure, will give you pleasure. My great traveller, Monsieur Linant, is at length with me, and has brought with him, in safety, the harvest of his journey to Napata and Meröe, and into the country beyond Senna'ar. There are maps and plans of every thing connected with his route, together with a very detailed journal, and about a hundred and fifty most beautiful drawings, all extremely detailed and minute, and some of them upon a very large scale. I find the ruins at Meröe magnificent beyond all expectation; but what interests me the most in their appearance is the striking admixture, which is very visible in them, of the Persian with the Egyptian style, and this not in the sculptured subjects only, but in the architecture also; no such resemblance being at all discoverable in any other ruins of that country, nor any where lower down upon the Nile. Surely this seems to be a wonderful confirmation of the tradition mentioned by Strabo, that Cambyses was the founder, and called the city Meröe, after the name of a wife or a sister, it was doubtful which: it seems to me probable that she was both; and if there be really any truth in the tradition cited, the circumstance recorded in the same passage, that the King carried Egyptians with him, will very sufficiently account for the edifice not being purely Persian, but rather of a mixed and grafted style. The bas-reliefs, however, seem to partake more of Persian than of Egyptian details. Strabo says of Cambyses: Προῆλθε *καὶ μέχρι τῆς* Μηρόης ΜΕΤΑ ΤΩΝ ΑΙΓΥΠΤΙΩΝ. *καὶ δὴ καὶ τοὔνομα τῇ τε νήσῳ, καὶ τῇ πόλει τοῦτο παρ᾽ ἐκείνου τεθῆναι φασὶν, ἐκεῖ τῆς ἀδελφῆς ἀποθανούσης αὐτῷ* Μερόης· *οἱ δὲ γυναῖκα φασί. τὴν ἐπωνυμίαν οὖν ἐχαρίσατο αὐτῇ τιμῶν τὴν ἄνθρωπον.* And Herodotus states, in his Thalia, that Cambyses was married to two of his sisters, though it is plain also, from the same passage, that it was contrary

to the Persian usage. Josephus, in that strange chapter of his *Antiq. Jud.*, where he gives the account of the expedition of Moses into Æthiopia, speaks distinctly and positively of the founding (or re-founding rather, and new naming) of Meröe, by Cambyses, it having before had the name of Saba. There is a large extent of ruin (but without any thing grand or architectural) at *Soba*, considerably south of Meroarat, near the junction of the Bahr el Abiad with the Abyssinian Nile. These last remains, however, I am well persuaded, are *not* upon the site of Meröe, and that Meroarat is its true situation; the position of this agreeing well with the distance given by the ancient geographers to that city from the junction of the Astaboras (*Atbara*) with the Nile.

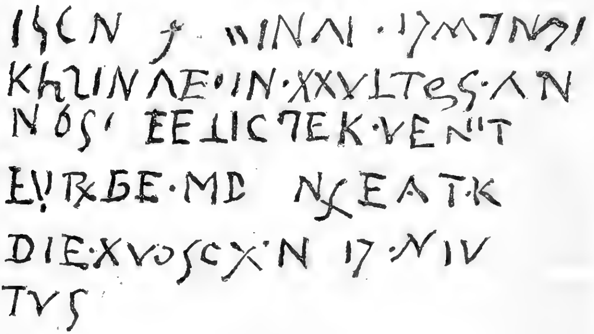
The next observation that I have to make upon the drawings is in confirmation of the report given by the spies sent up by Nero, which is preserved in Pliny. They spoke of the principal temple at Meröe being dedicated to Ammon (which is evidently proved by the sculptures on it), and that there were many lesser temples in the country round about, which is also true; that the city was in those days become a small one, which is confirmed also by the very little traces that remain of inferior buildings, or heaps of rubbish about the temple. I had always cherished a faint hope that some vestiges might be found of these Roman military spies, the custom being very general, of recording upon the public edifices all along the Nile, even the most ordinary visits.

I was very anxious for any token of inscription from Meröe: there are some scraps of Coptic, which are, perhaps, Christian, and seem to promise nothing of interest, of which I have copies; but there is one also, which, I regret to say, seems to have been very ill copied, which has a much more inviting appearance: it is certainly in Latin; and, therefore, I take it for granted, not of Christian times. All Egypt furnishes no more than two or three scanty instances of inscriptions in Latin; and to find this language at Meröe is, therefore, so unexpected, that I cannot help suspecting it to be the work of the Tribune, or of some of his companions, sent up by Nero to Meröe as spies: I can, however, make very little of it, for Linant, seeming to have taken it for granted that (because it was cut in a

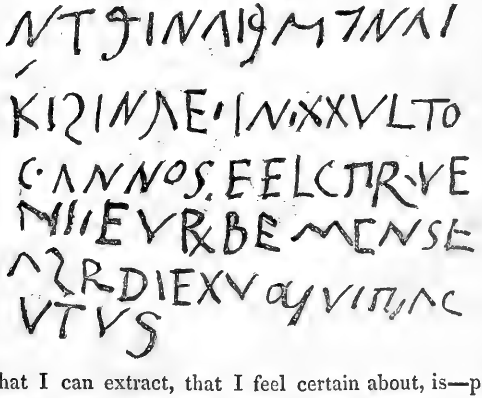
slovenly manner) it was of no interest, has made but a careless copy, instead of conforming to my injunctions in making several at different times of the day. I fortunately, however, have two (such as they are); for my old interpreter and janissary, Mahomet, who was with Linant, attempted another. I inclose a tracing from both of them:

Inscription on the wall of the great staircase among the ruins of Meraurát, which is probably the ancient Meröe.

As copied by Linant.



As copied by Mahomet.



All that I can extract, that I feel certain about, is—possibly [*REGINAE*] XXV . ANNOS . FELICITER . VENIT . *VRBE*. MENSE . A[*THO*]R . DIE . XVO.

The passage in Pliny, which I have my eye upon, is this: "nuper renunciavere principi Neroni missi ab eo milites prætoriani cum tribuno ad explorandum." They brought word that "Ædificia oppidi pauca; regnare fœminam Candaocen, quod nomen multis jam annis ad reginas transiit. Delubrum Hammonis et ibi religiosum, et toto tractu sacella." The god, who is represented receiving the offerings upon the columns of the great temple, has the ram's head, as at Diospolis and at Siwah; and there is sufficient evidence of the truth of the remainder of the paragraph in the vestiges of other religious structures which remain.

It was, indeed, this short passage in Pliny that gave me so keen an appetite for having that region well explored.

Another accordance with the history of a country, about which we know so little, has struck me exceedingly: it is in the circumstance of the Royal Personage represented in the sepulchral chapels attached to the numerous pyramids, with the diadem, and in the act either of slaying, or of being presented to the god, being in many instances female; a circumstance rarely, if ever, seen in Egypt, and seeming to stand there in proof of the reign of the several Candaces, whom we read of in history; a name which, Pliny says, was common to them, and which, doubtless, was simply, in Æthiopic, the word signifying *the Queen.* Some points are observable also in these figures, which are remarkable as being in conformity with the present usages and prejudices of that barbarous country. The Queen is represented with nails as long as the talons of a bird, a particular never observable in Egyptian sculptures, neither is there any such modern usage in Egypt, but in the upper country about Senna'ar and Meröe this is very general amongst the women. There is also represented in the same sculptures a sort of ring, which, though worn on one finger only, has a broad plate attached to it, which extends across the whole back of the hand; this also does not occur, either in ancient or in modern Egypt, but is common in the districts where these sculptures occur, with the women, to this day. Again, the form and outline of these Candaces are very remarkable, and quite without example, on the storied buildings, lower down upon the Nile; the form below the waist

being almost that of the Hottentot Venus, both as to the hips and behind. This is considered in Abyssinia as a great mark of distinction and high birth. There was, when I first went to Jerusalem, an Abyssinian Princess there, upon a pilgrimage, the daughter of a deceased King, most remarkably proud in this respect, and who piqued herself greatly upon it. I have heard an English Lady say, that she could not believe the peculiarity to be natural till she saw the lady in the bath. None but the Queens are honoured with this figure in the bas reliefs, the female attendants and the goddesses being as slender and as scanty as elsewhere upon the Nile. The gods seem to have been the same as in Egypt, only there is one with a sort of lotus head, that I do not feel well acquainted with; and the lion-headed Isis has, in one instance, both her head and her arms tripled, so as to bear a great affinity to the Indian deities.

The country is not like Egypt, but covered with herbage and abounding in forests, with monkeys leaping and chattering in the branches: this circumstance, the historical sculptures lower down had led me to expect, where the conqueror (probably Sesostris) is represented chasing a naked people with flat noses and thick lips into forests, in which monkeys are sitting, evidently placed there to designate and characterize the country where the event took place.

Linant observed no parrots, though Pliny very exactly sets down (on the authority of the spies) the name of the place where they are first found in following the Nile upwards; always taking it for granted that Psittacus should be so translated, of which I am by no means sure. Both Linant, however, and an attendant who was with him, speak in high terms of the beautiful plumage of many of the birds which they saw (several of the skins they have brought with them, but I have not yet got them from Milford), and of the shrill cries and discordant notes which proceed from them, especially about daybreak. The Ibis, so common in ancient times, but now unknown in Egypt, is often seen, and is said to frequent the streets even of Senna'ar (as Alexandria anciently), in a very confident and domestic manner, at some seasons of the year, but not in that when Linant was residing there. The Guineafowl abounds.

Of the larger animals, there are droves of wild elephants, but none in a reclaimed or domestic state (neither are there any, I apprehend, in Abyssinia), which seems to be very strange in countries where the people have been always warlike. The Hippopotamus is common in the river, and the whips (called Coorbash) sold in Egypt, are really manufactured from its hide; and not from the elephant's, as I have heard pretended at Cairo. This creature is not of the form in which it appears in all our plates of natural history; it is of a much lower and more lengthened proportion, which I had myself imagined from the skin and remains of that which I saw recently killed at Damietta, in my last journey. Its cry is a sort of loud grunting, very hideous and alarming, especially in the night time; but it is not considered a ferocious or dangerous animal; neither did any which Linant saw exhibit the appearance of those protruded tusks which are shown in the pictures of this animal. He saw some that were of a bay colour, and had white faces; this possibly may account for the strange misnomer both in Greek and in Arabic, of calling a creature, so very differently shaped, the river *horse*.

The abundance of camels (of course domestic) is so great, that no meat is commoner in the market at Senna'ar or Shandy; those which become unserviceable being killed for eating. Wild swine are found in great numbers in the moister places, and are eaten by many of the natives, though Mahommedans, without scruple, who will also both eat raw meat occasionally, and drink the warm blood of living animals. The wild ape goes in large herds. The giraffe was spoken of as of no very rare occurrence; but Linant met with none in a wild state; he was, however, so lucky as to see one at Senna'ar, brought thither by the natives (the same as has been since sent as a present to the Grand Seignior, and is, I apprehend, now alive at Constantinople): this was at that time very young, and no bigger than a fawn: very gentle and docile in its disposition: it then fed upon milk, straddling out its legs very wide, in order to reach the ground, which, with so very long a neck, one should hardly have thought necessary, though this has always been said of it. The natives uniformly spoke of the Unicorn as of a real and known

animal, and to the usual description of its form added, that the horn was moveable at the creature's pleasure; a circumstance which, from the position of it, seems impossible.

Linant still seems to cast a wistful eye on the White River, upon which he had a great desire to have proceeded. A strange story was told him by the Jellabs, and persons who had come from above, that there is a place, where, after becoming immensely broad, this Bahr el Abiad turns and flows to the westward, which is only possible [?] by supposing a great lake, out of which two similar streams proceed, one running westwards, and one falling into the Nile. The Blue river, the Nile of Bruce (and, in justice to Bruce, we must add of the people of the country), is so nearly dry at one season, that Linant himself crossed it when there were but a very few inches of water in the channel, the Bahr el Abiad having then a full and strong current. * * *

W. J. B.

Remarks on the Inscription at MERÖE, *in reply to Mr. Bankes.*

26*th Nov.*

MY DEAR SIR,

I can only make out with confidence: IN MVLTOS. ANNOS . FELICITER . VENIT . E . VRBE . MENSE . APR. DIĒ . XVO.; then, perhaps, SEX . VIRIS . ADIVTVS. The beginning is probably irrecoverable, but it may have been something like C . ANT . HEMINA . COMITVM . AGRIPPINAE. I think there was a Cassius *Hemina* (Pliny, iii. 30), but whether it was that name or *Apollinaris*, or any other like it or unlike it, I will not pretend to determine: but it would be glorious for your conjecture if we could establish its being *an attendant of Aggrippina for many years . . . with six assistants.* I cannot make out any thing like TH in the month, and I doubt if *Athor* or *Athyr* could ever have been contracted into ATR. Instead of Agrippina, or Agripina, perhaps the word was AVRIFODINAE; and, possibly, even AFRICANAE: but it would be difficult to fill up the blanks on this supposition. What is become of your Homer?

Believe me, always,

Very truly yours, T. Y.

ART. IX. *On the Radiation of Heat in the Atmosphere; in reply to Mons. Gay-Lussac.* By J. F. Daniell, F.R.S.

MONS. Gay-Lussac has done me the honour to announce, in the *Annales de Chimie* for August, 1824, his intention of submitting the different chapters of my Meteorological Essays to a detailed examination. Nothing could give me greater pleasure than the fulfilment of this promise; for I am aware that I have ventured, in that work, to propose many novel opinions, which I can only hope to see established after a full and candid discussion. He has commenced the task with the Essay upon the Radiation of Heat in the Atmosphere; and this not being the first, either in place or importance, naturally suggests an inquiry as to the reason of the selection. Three numbers of the *Annales* have since been published without resuming the subject; and this interval, together with the want of candour which, it grieves me to say, I shall presently have occasion to expose, suggest the idea that the Reviewer was content with an impression which he conceived it was easier to produce through this channel than that of any of the others. Mons. Gay-Lussac has formerly treated me discourteously, upon the subject of the hygrometer, and flippantly upon the present occasion; but, in my reply, I shall endeavour not to forget that it is one of the first philosophers of the age who has condescended to enter the lists against me, and one for whose talents and acquirements I have the sincerest admiration and respect.

Mons. Gay-Lussac, by fixing upon one expression in my paper, has made it appear, to those who will look no further than his review to form their opinions (and many such there are), that I have advanced certain most untenable conclusions with *confidence* and *presumption*. It will scarcely, therefore, be believed by them that I have taken more than ordinary pains to guard against any such imputation. I have expressly stated, that I was sensible that "my observations were in a very imperfect state; and that I only ventured to bring them forward in the hope of exciting some attention to a subject which appeared to me to be well worthy of eluci-

dation, and to suggest some experiments, which, to render them beneficial, require much perseverance and extensive co-operation." To those who have done me the honour to read the Essay, I may confidently appeal whether I have not, throughout, maintained that tone of diffidence which the sense of incompleteness required.

From eighteen months' observations of my own, in this country, compared with twelve months' observations of Captain Sabine, at different intervals, and at different places between the tropics, I thought I saw reason to conclude that the force of radiation from the sun was greater in the former than in the latter situation. I was aware (and I so expressed myself) that the instruments made use of were not sufficient to determine the question with any degree of nicety; but I thought that the irregularities to which they were subject would be in some measure neutralized by the number of the observations. It was from the *entire* number of observations in this country, compared with the *entire* number between the tropics, that I conceived myself entitled to argue. Mons. Gay-Lussac has most ingeniously made it appear, that I have drawn a strict comparison with each experiment at each respective place; and he thereupon pleasantly remarks, "Si M. Daniell, pensait que j'accorde une trop grande influence aux circonstances locales, je lui signalerais une nouvelle découverte qui découlerait alors trop directement de ses observations pour qu'il ne fût pas juste de lui en laisser tout l'honneur: ce serait que le soleil, par des latitudes égales, a une force échauffante, plus grande en Amerique qu'en Afrique, et sur le continent que dans les îles."—To Mons. Gay-Lussac be the anticipated honour of this misrepresentation. My argument is this—Captain Sabine (whose rare accuracy in making observations is well known in this country, and is likely ere long to be as well appreciated in France) undertook to measure the force of solar radiation between the tropics, by observing its effects upon a thermometer prepared to receive its greatest impression, placed in the most unexceptionable manner that circumstances would allow, and by comparing them with another screened from its influence, marking as nearly as possible the mean temperature of the air. To accomplish this

object, he selected his opportunities at different stations: but *only once*, at Bahia, did he obtain a result which even equalled the mean power of the sun for two years, in this country, in the month of June; *all the cloudy days* being included in the average: and which fell short, by one-third, of the maximum effect which often occurred in clear weather, measured by the same means. Mons. Gay-Lussac objects that the thermometers were not always placed at equal distances from the ground and from the vegetation on it, and that they were not equally secured from currents of air, &c. &c.; but it must be admitted that there is ample room for allowances of this kind, and yet to save the conclusion, which is only general, that the power of solar radiation is less between the tropics than in higher latitudes. He has also forgotten to mention, that these results were confirmed by others obtained with instruments of more delicate construction; in which the thermometers were placed *in vacuo*, one being armed with a case of polished silver to repel the rays, and the other with a blackened surface to absorb them. Bnt I again repeat, that if Captain Sabine *but once* succeeded at any *one station* between the tropics in obtaining the full impression of the sun upon a blackened thermometer, or even approached the full impression within one-third, that there is ground for the hypothesis.

Captain Sabine has not been accused of having sought the maximum power of the sun upon cloudy, windy, or foggy days; but an argument of equal force is employed to controvert the results of his experiments upon terrestrial radiation at night: for, says M. Gay-Lussac, "On pourra, ce me semble, se borner â deduire des observations qui précèdent, que, du 24 an 30 Juillet, pendant le séjour de M. Sabine à Bahia, l'atmosphêre y était moins calme ou moins pure que dans les jours du même mois oû M. Daniell à trouvé á Londres un rayonnement nocturne de 8 ou 9 centigrades." Those who are practically acquainted with the usual serenity and beauty of an intertropical sky, those more especially who have described the splendour of the stars and the beauty of the constellations within the torrid zone, as differing so much from what we are accustomed to in our turbid atmosphere,

will doubtless give him credit for the patience and perseverance with which he must have sought for opportunities, inconsistent to be sure with the object which he had in view, but at the same time remarkable and rare.

We have seen with what ill fortune a gentleman of Captain Sabine's acquirements attempted to place his thermometers so as to obtain something like an approximation to the power of the sun; and that, during the course of a complete year, with selected opportunities, he did not once succeed (for once will be sufficient to establish the argument) in obtaining the object which he had in view. Let us now turn to the unpremeditated observations of those who, having no object in view, and being unprepared with even the rough apparatus which has been described, had their attention called to the prodigious power of the sun's rays in high northern latitudes. Chance now brings about what science could not effect, and the thermometers are all at once placed in the most favourable positions for indicating the extreme effects! The bulb of the instruments in this instance were not covered with black wool, or even blackened superficially, but then "Qui ne sait combien la force réfléchissant de la neige est considerable? Il aurait fallu faire, par le calcul ou par l'experience, la part de cette réflexion, avant de comparer les observations de Londres avec celles du Capitaine Parry." Let M. Gay-Lussac fairly make the calculation of the effects of this reflection on one side, and of the blackened bulb on the other, and I do not fear that my reasoning will be shaken by the result.

To assist in forming a right conclusion upon the subject, let the following additional fact, extracted from Captain Lyon's interesting Journal, be taken into consideration; the place of observation and the date are, Igloolik, 16th February:—"I observed, even while the temperature in the shade was 35° below zero, that fine powder of snow melted under the influence of the sun when sprinkled on a stick covered with soot; thus making a difference of temperature existing at the same time as great as 67° and upwards."—*Lyon's Journal*, p. 389.

Here the coating of soot renders the experiment very closely

comparable with a thermometer covered with black wool, with which the utmost effect I ever obtained in the month of February, in this country, was 36°. The difference, therefore, of the power of the sun in the two situations was 31°; from which, let any reasonable deduction be made for reflection, and the remainder will be amply sufficient to support my conclusion.

M. Gay-Lussac has entirely omitted to mention a confirmation of my argument, upon which I place very great reliance, and which, possibly, it was more agreeable to him to overlook, than to refute by the same species of reasoning which has been deemed sufficient for Captain Sabine and me. M. de Humboldt "*often* endeavoured to measure *the power of the sun* between the tropics, by two thermometers of mercury perfectly equal, one of which remained exposed to the sun, while the other was placed in the shade. The difference resulting from the absorption of the rays in the ball of the instrument *never* exceeded 3°.7. (6°.6. Fahr.); *sometimes* it did not even rise higher than one or two degrees."

What! Did M. de Humboldt also select days for his experiments, "quand l'atmosphère était moins calme ou moins pure que dans les jours du même mois à Londres?" or was he so little skilled in experiment as not to know how to place his instrument so as to receive the full impression which he wished to measure?

Captain Sabine tried the very same experiment with a naked thermometer at Jamaica, and obtained the same result, namely, 3.1 centigrade degrees between the sun and the shade.

Will Monsieur Gay-Lussac say, that we have no analogous experiments in these northern latitudes to compare with those of the uncoated thermometers? I refer him to the Ephemerides of the Meteorological Society of the Palatinate, published in 1783 and following years; in which he will find a register of the power of the sun at Manheim, measured by equal and carefully-adjusted thermometers, with naked bulbs, nearly every day in the year for several years. He will there see a difference of from 5 to 7 octogesimal degrees (6.3 to 8.7 centig.) often recorded.

I will now take the opportunity of introducing another argument in favour of my hypothesis, derived from a very different source,

which I have lately met with, and which has afforded me much satisfaction. Mr. Andrew Knight, the President of the Horticultural Society, well known for his admirable and practical remarks upon the physiology of the vegetable kingdom, has observed that pine-apples, ripened in the house during the winter, have proved of great excellence. He suggests that this fruit will ripen better early in the spring than in the summer months; "for," he says, "this species of plant, though extremely patient of a high temperature, is not by any means so patient of the action of very continued bright light as many other plants, and much less so than the fig and orange tree: possibly having been formed by nature for intertropical climates, its powers of life may become fatigued and exhausted by the length of a bright English summer's day in high temperature."—*Hort. Trans.* vol. iv. p. 548.

Will M. Gay-Lussac yet agree with me in thinking that the modification of the power of the sun's rays is largely concerned in the curious effect here pointed out?

But M. Gay-Lussac not only labours to overthrow the hypothesis which I have advanced upon the radiation of heat in the atmosphere, but brings forward and supports another, which is certainly, it must be admitted, sufficiently inconsistent with its admissibility and truth. This is founded, it appears, upon experiments of M. Flaugergues, and " comme toutes les précautions avaient été prises pour soustraire l'instrument, autant que possible, aux rayons réfléchis par le sol et les objets voisins, les résultats obtenus par cet observateur paraissent mériter toute confiance." But now I must acknowledge with shame, that I have some difficulty in extending to my Reviewer the courtesy which he lavishes upon me. " Ces doutes," he has kindly assured me, "je les ai uniquement puisés dans l'examen des observations, et la singularité ou, si l'on veut, l'improbabilité du résultat qu'en déduit M. Daniell, n'y est entrée pour rien." But prejudice, I grieve to say, at once took possession of my mind upon reading the result of M. Flaugergue's researches: a result, however, which even M. Gay-Lussac is compelled to designate as " fort singulier."

" Voici en quoi ce résultat consiste."

"*Les rayons solaires ont la même force calorifique en hiver et en été.*"

"Résultat qui paraitra fort singulier, et que l'auteur regarde comme la confirmation d'une ancienne hypothése de De Luc suivant la-quelle *la lumière doit produire d'autant plus d'effet que son trajet dans l'atmosphère a été plus long.*"

The observations were made with a thermometer, having its bulb blackened with Indian ink; but as we are not informed what were the special precautions adopted to render them, in M. Gay-Lussac's opinion, "worthy of all confidence," it is impossible to return the compliment of a rigid examination of them.

M. Flaugergues, however, has arrived at one result, with which M. Gay-Lussac cannot altogether bring himself to acquiesce; it is as follows:—"si les différences entre les deux thermomètres sont plus grandes par un temps calme que quand le vent souffle, *cela ne dépende pas du plus prompt refroidissement, que le mouvement de l'air doit amener dans l'instrument exposé an soleil; c'est par une modification particulière de la lumière qu'elle ne produit pas autant d'effet calorifique lorsque l air est en mouvement.*"

And now, how will it be supposed that the dissent from this opinion is expressed? Doubtless with some such strong language as that adopted with regard to the unfortunate observations of Captain Sabine and myself—"Ce ne serait qu'après avoir oublié *les notions les plus élémentaires de physique* qu'on pourrait se permettre de comparer immédiatement entr'elles des observations faites dans des circonstances aussi dissemblables." No such thing—thus politely and delicately is the conclusion dismissed—"Cette singulière opinion n'ayant point reçu l'assentiment des physiciens, il serait inutile de la discuter ici."

Verily it is a good thing to have been born on the right side of the Pas de Calais!

But I have done—Mon. Gay-Lussac will excuse me, if I have been betrayed into levity of expression. I have endeavoured to answer his remarks somewhat in the same style in which they were conveyed; if there be any bad taste in adopting such, in scientific discussions, the offence will not rest with me. I again repeat that

or his talents and vast acquirements I have the most unfeigned respect, and I beg to assure him that, if he should hereafter condescend to redeem his pledge of analyzing the remaining Essays of my book, in the true spirit of philosophic inquiry, I shall esteem myself most highly honoured.

Art. X. *On Evaporation; by* John Bostock, M.D., F.R.S., *in a Letter to* J.F. Daniell, Esq.

Dear Sir,

In perusing the account of your Experiments on Evaporation, in No. XXXIII. of the *Quarterly Journal,* I was struck with the coincidence of their results with some which I obtained several years ago, on the same subject. My object was to ascertain the absolute amount of evaporation, from a given surface of water, in different states of the atmosphere. I employed, for this purpose, a shallow silver dish, of two inches in diameter, with perpendicular sides. The dish, containing 100 grains of distilled water, was accurately weighed; the thermometer, barometer, direction of the wind, and other atmospherical phenomena, which might be supposed to affect the results, were noticed. A small China cup of water was placed near the dish, in which a delicate thermometer remained immersed during the experiment. The dish and cup were inclosed in a glass cylinder with an open top, in order to prevent the current of air from accelerating the evaporation, while, at the same time, the surface of the water was freely exposed to the atmosphere. After a certain interval the dish was again weighed, and the loss of weight noted.

I was induced to undertake the experiments for the purpose of ascertaining how far the rise and fall of the barometer was affected by the quantity of water dissolved, or suspended in the atmosphere. They commenced in July, 1812, and were continued, occasionally, until January, 1815, when the results were found so little to support the hypothesis that I had formed, and appeared altogether so anomalous, that I discontinued them, and laid them aside, as of no value. I can, however, venture to assert, that they were made

with great care, and that their results were always accurately registered at the time they were performed; they may, therefore, be useful as matters of fact, and more especially as viewed in connexion with your valuable researches on meteorology. The number of experiments which I have on record is 162; some of these are, from various circumstances, more or less imperfect, yet there are 130 which I think are not liable to any exception, and which I have, therefore, employed in forming the general conclusions.

It is not my intention to trouble you with the relation of all these, but I shall select a few, which may be taken as a specimen of the manner in which they were conducted, and I shall afterwards endeavour to form some kind of synoptical view of the whole.

The three following series, consisting each of ten experiments, are selected from different parts of the journal, as showing the state of evaporation in the months of December, May, and August.

No.	Date.	Time of the day.	Barometer.	Thermometer out of doors.	Wind.	Temperature of the water.	Length of the experiment.	Total loss of water.	Quantity evaporated per hour.	MISCELLANEOUS OBSERVATIONS.
	1812. Dec.	h. m.		°		°	h.	gr.	gr.	
1	1	12·45 P.M.	29·88	48	SE	52	1	·4	·4	Calm, cloudy, mild rain.
2	—	2·50 P.M.	29·86	46	NE	52	4	·8	·2	Rain continues, gentle breeze, barometer falling.
3	3	8·37 A.M.	30·15		E	53½	1½	·6	·4	Nearly calm, fog, misty rain.
4	—	10·10 A.M.	rising.		E	53½	1	·3	·3	Less foggy, weather clearing.
5	—	11·15 A.M.	rising.		E	54½	4	1·25	·3125	More rain in the afternoon.
6	6	4·15 P.M.	30·40	39	ENE	50	3	2·05	·683+	Bright, with haze in the horizon, nearly calm, slight frost.
7	10	9·36 A.M.	29·94	34	NNW	42½	2	·45	·225	Fog, which was dispersing, calm, thaw.
8	16	8·15 A.M.	29·40	28	ENE	41	2	·9	·45	Brisk cold wind, bright, frosty.
9	17	12·95 P.M.	29·16	33	ENE	42½	2	·65	·325	Cloudy, tending to thaw, a little rain, brisk wind.
10	19	9·23 A.M.	29·47	34	ESE	43	1	·6	· 6	Uniformly cloudy, gentle breeze, decided thaw.

No.	Date.	Time of the Day.	Barometer.	Thermometer out of doors.	Wind.	Temperature of the Water.	Length of the Experiment.	Total loss of water.	Quantity evaporated per hour.	MISCELLANEOUS OBSERVATIONS.
	1813.	h.m.					h.	gr.	gr.	
1	July 31.	12.30 P.M.	29·83	71°	W	71½°	1	1·11	1·11	Cloudy, gentle breeze.
2	Aug. 1.	4·15 P.M.	29·94	71	S	70	1	1.1	1.1	Partially clear, calm, sultry.
3	4	2·30 P.M.	29·69	66	W	64½	4	7·1	1.775	Partially clear, brisk wind, with flying showers.
4	5	10·0 A.M.	29·42	60	SSE	59½	1	·25	·25	Brisk wind, beating showers, barometer fell rapidly.
5	—	2·10 P.M.	29·43	66	W	64	1	1·1	1·1	Wind shifted to west and abated; became clear.
6	6	12· M.	29·56	60	WNW	63	1	·75	·75	Partially clear, brisk wind.
7	—	1 P.M.	29·59	61	WNW	63	2	1·6	·8	Became more clear, wind abated.
8	7	9·30 A.M.	29·88		WNW	65½	3	2·6	·866+	Bright, partially clear, breeze.
9	8	1 P.M.	29·86	64	SSE	63	2	1·25	·625	Cloudy, gentle breeze, light rain.
10	9	10.45 A.M.	29·94	63	W	63½	9	8·5	·944+	Fresh breeze, large heavy clouds.
	1814.	h.m.					h.	gr.	gr.	
1	May 5	12.15 P.M.	29 60	47°	E	49½°	3	2.61	.87	Cloudy, breeze, continued rain in the afternoon.
2	6	1·30 P.M.	29·34		E	47	2	2·	1·	Breeze, rain for eighteen hours with little interruption.
3	7	12.30 P.M.	29.66	51	SE	49½	6½	4·5	·692+	Cloudy, nearly calm, mild showers.
4	9	12.50 P.M.	30·18	54	ESE	52½	3	2·4	·8	Partially clear, gentle breeze.
5	10	3 P.M.	30·40	54	ENE	51½	3	4	1·33+	Breeze, partially clear.
6	11	11.50 A.M.	30·46	54	NW	52	4	5·2	1·3	Wind suddenly changed from E. to W. during the experiment.
7	13	12.40 P.M.	30·14	50	N	50	2	1·2	·6	Cloudy, calm, tendency to rain.
8	18	1 P.M.	30·16	62	ESE	59½	3	2·3	·766	Partially clear, gentle breeze.
9	23	1 P.M.	29·67	51	N	50	2	1·6	·8	Cloudy, breeze, showers.
10	June 6	1.45 P.M.	30.10	52	N	53	1	·8	·8	Cloudy, cold breeze.

The quantity of evaporation during an hour, from a circular area of water of two inches in diameter, taking the average of 130 experiments performed on different days, of which 93 were made during the winter months, from November to March, both inclusive, and 37 during the summer months, from May to September, both inclusive, is .5596 grains; or, taking the average of the first 37 winter observations which occur in the Journal, and of the 37 summer observations, the quantity will be ·634 gr. per hour.

The average of the 93 winter observations is ·421 gr., or of the first 37 which occur in the Journal, ·4223 gr.; the average of the 37 summer observations, is ·908 gr. per hour.

With respect to the comparative rate of evaporation during the different months, the following are the averages of 149 experiments, chiefly performed during single hours on different days.

For January	·287 gr. per hour.	July . .	·983 gr. per hour.
February .	·400	August .	·932
March . .	·393	September	·555
April . .	—	October .	·346
May . .	·897	November	·369
June . .	·930	December	·392

The experiments, as appears by the Journal, were frequently continued for more than one hour on the same day, when, as circumstances allowed, the results were either examined at the end of each successive hour, or an average was taken of the whole. In this way, the Journal contains the results of 1188 hours, the average of the whole of which is ·501 gr. per hour. Of these 942 were during the winter months, and 246 hours during the summer. The average of the 942 winter hours, is ·43 gr., of the 246 summer hours ·77 gr. I am not aware of any cause which will account for the winter evaporation appearing to be greater in this case, than when the average of single hours on different days is taken. We perceive, on the contrary, that the average of the summer evaporation is less than that indicated from the experiments performed on single hours; perhaps, this may depend on the operation in the former case having been protracted until late in the evening; and, in a few instances, carried on during the night, whereas the single experiments were generally performed during the forenoon.

The greatest quantity of evaporation, in one hour, is 1·75 gr.; it occurred on August 4th, 1813; the least quantity of evaporation was on the 12th of November, 1812, when no loss of weight could be perceived: on the 1st of December in the same year, it appeared that there was even some increase of weight. The greatest winter evaporation was on the 28th of November, 1812, amounting to 1·08 gr., and the least summer evaporation on August 5th, 1813, amounting to ·25 gr. per hour.

The average of fourteen winter observations, with the wind in a S. or W. point, is ·346 gr. per hour; of fourteen summer observations, with a S. or W. wind, is ·882 gr.; of fourteen winter observations, with the wind in a N. or E. point, is ·546 gr. per hour; of fourteen summer observations, with a N. or E. wind, is 1·03 gr. per hour.

In order to observe whether the rate of evaporation was affected by the height of the barometer, the barometric scale from 29·20 to 30·20, was divided into ten equal parts, and the same number of observations being taken under each division, the respective quantities of water evaporated per hour were as follows: ·381, ·451, ·436, ·386, ·76, ·75, ·51, ·545, ·565, and ·471, gr. If we are to consider the relation which these numbers bear to each other as any thing more than accidental, it would appear that the state of the atmosphere which is attended by either a very low or a very high barometer, is less favourable to evaporation than the intermediate state. Nor does it seem unreasonable that this should be the case. Damp or wet weather, which is generally accompanied by a low barometer, is obviously unfavourable to evaporation; while, when the barometer is high, the atmosphere may be supposed to be more nearly saturated with moisture, and, therefore, less disposed to receive an additional quantity. According to the preceding observations the interval between 29·60 and 29·80 would appear to be the most favourable to evaporation, while the range above 29·80 is more favourable to it than below 29·60. I could not perceive that the condition of the barometer, with respect to its being in the rising or falling state, independent of its absolute height, bore any relation to the amount of evaporation.

The connexion between temperature and evaporation was next examined. The experiments were classed under five heads, according to the degree of the thermometer at which they were performed; those under 40°, those between 40° and 50°, between 50° and 60°, between 60° and 70°, and lastly those above 70°. The four first divisions contained an equal number of observations; the last was less numerous. The average quantity of evaporation per hour, in the five divisions, was ·47 gr., ·352 gr., ·45 gr., 878· gr., and 1· gr. respectively. The four last numbers indicate, as might be expected, a close connexion between temperature and the rate of evaporation; and the apparent anomaly in the first of the numbers may be explained upon the principle, that the greatest degrees of cold are generally accompanied by N. or E. winds, which, in other respects, are the most favourable to evaporation.

The above results appear to be fairly deducible from my experiments, and, if not in themselves of any great importance, may, I conceive, be of some value as connected with the researches which have been carried on by yourself and others on the same subject.

I am, dear Sir,

Your's, with much esteem,

J. Bostock.

Art. XI.—*Experiments on Oil of Mace, communicated by* Mr. Wm. Bollaert.

Genuine oil of mace is a greasy substance of a dark yellow colour; its smell is very aromatic; it is about the consistency of hard butter, and its exterior is occasionally somewhat crystalline.

When submitted to distillation with water, a highly odorous essential oil arises, and by such repeated distillations, a substance remains which is completely inodorous. The essential oil exists in it, in very small quantities only. The substance which forms the subject of the following experiments, was found in examining the above oil, as well as some other aromatics, with a view to ascertain the nature of the acid matter which most of them contain.

This acid was supposed to be the benzoic, and though it was expected that that acid would pass over in the above process of distillation with water, yet, after repeated trials and experiments, it was found it could not so be procured, nor were any satisfactory results obtained, for the acid matter was in too small a quantity to determine its nature.

Solution of potash was added to some oil of mace, which apparently neutralized the free acid matter that exists in it; but on closer investigation, it was found, that the alkali was acting on a part of the oil, forming with it a saponaceous compound; whilst another portion separated, of an oleaginous appearance: more alkali was added, and the whole allowed to boil, which caused a more complete separation of the oleaginous portion: as excess of alkali was used, it was pretty certain that all the common fatty matter present would combine with it: but though such excess of alkali was used, no action was observable on the oily portion that had separated.

The whole was allowed to cool, the oleaginous matter then solidified, it was collected, washed and dried, and found to have the following properties.

It was of a whitish appearance and crystalline texture, perfectly insoluble in water, insipid, inodorous, and very fusible. Its boiling point was about 600°, at which temperature it may be distilled without much decomposition; it is very inflammable, and contains no nitrogen.

Sulphuric ether, at common temperatures dissolves it readily: cold alcohol acts upon it but feebly, but when boiled upon it dissolves it abundantly, and deposits it as it cools.

The solutions of the alkalis have no action upon it, even at a boiling temperature.

It mixes and easily combines with the fixed oils, if aided by a little heat.

The acids apparently have various effects on this substance. Sulphuric acid chars and decomposes it, forming a dark-coloured solution.

Nitric acid, when digested on it, changes some of its properties;

nitrous vapours are evolved, the substance acquires a yellow colour, and readily saponifies with the alkalies, it retains its crystalline texture, and is in other respects apparently unaltered. When muriatic acid is boiled on it, no action is perceptible, nor any change in the substance.

The oil of mace affords about one-half of this peculiar principle.

The fatty portion originally referred to, was in combination with potash, and was separated from it by muriatic acid, and when purified, was found to have the following properties.

It is insipid and inodorous, of a yellowish colour, breaking with a fracture similar to tallow.

It combines with the fixed oils, if aided by a little heat.

It is readily fusible; it boils at about 600°, and it may be heated to this high temperature without much decomposition. It is inflammable; it affords no evidence of containing nitrogen when subjected to destructive distillation. Ether, at common temperatures dissolves it readily; cold alcohol dissolves it but sparingly, but when boiled on it dissolves it readily, depositing it as it cools.

It combines with, and neutralizes the alkalies, forming true saponaceous compounds.

Sulphuric acid chars and decomposes it. Nitric and muriatic acids have little or no action on it.

I have lately ascertained the presence of *benzoic acid*, in the following vegetable substances.

Acharoides Resinifera, or Botany-Bay gum: the botanic name of the tree yielding it, is Xanthorea Hastile; this substance affords about six per cent. of benzoic acid.

The substance which is deposited from the essential oil of bitter almonds, (See *Journal of Science*, vol. xv. p. 155, 376,) has all the properties of benzoic acid.

A deposit from the oil of Cassia, which formed crystalline filaments, consisted also almost entirely of benzoic acid.

Art. XII.—*Observations on Naval Architecture, and on the state of Science in our Dock-Yards.*

The public attention has at length, by the experimental attempts of Sir Robert Seppings, Professor Inman, and Captain Hays, been excited respecting ship-building; an art of transcendent importance to this country, but which has been most singularly neglected. The time, it is to be hoped, is at length arrived, when the benefits that science is capable of conferring on it will be acknowledged; and a due value set on the efforts of those who may employ their ingenuity and talents, in advancing its interests. By far the major part of our *present* knowledge of naval architecture has been derived from an imperfect *experience;* the principles and maxims of theory having had but little to do with its improvement. It is not, however, that theoretical men have been inactive; or that an art, which is identified more than any other with the most important interest of man, has been neglected by those who are capable, from their talents and their superiority in science, of contributing to its successful advancement; but because those who have hitherto had to do with its practical exemplification, have in an unaccountable degree neglected the cultivation of those branches of knowledge on which ship-building so essentially depends.

The contrast between civil and naval architecture, in this point of view, is remarkable. The former has derived accessions of strength of no ordinary importance, from the application of science; and has numbered, among its cultivators, men who have obtained immortal renown by the perfection they have imparted to their works, by judiciously blending the principles of science with the maxims derived from a sound experience. The latter, on the contrary, has seldom enjoyed the good fortune of having had its operations guided by rules, deduced from so salutary an union. The cultivators of naval architecture have, in general, been in the truest sense *practical,* the torch of geometry seldom illuminating their path; and hence it has happened, that our present knowledge of some of the most essential elements of ship-building is limited and imperfect in the extreme; nor would it be perhaps too much to

assert, that there is scarcely a *single element* in which the naval engineer can predict with certainty what will be its effects when actually applied.

There are difficulties, it will be readily admitted, in this art, which are peculiar to itself, and perhaps appertain to no other. But although it may be impossible to surmount, even by the aid of the most enlarged experience, or the employment of the most refined and powerful calculus, *all* the obstacles that oppose its advancement; still some considerable approaches may be made towards perfection, by gradually imparting to our practice, a more philosophical character than it now possesses. It cannot be denied that a geometrician contemplates a mechanical combination in a manner peculiar to himself, and with advantages far surpassing those of a man destitute of such important resources.

It cannot be concealed, that until the establishment of the school of naval architecture in Portsmouth Dock-Yard, few persons in any of our naval arsenals ever thought of guiding their practice by maxims drawn from the legitimate principles of science; nor did the properties of the metacentre, or of the resistance of fluids, ever form a subject of intelligent discussion within their walls. Nor again must the fact be omitted, in the consideration of this most important subject, that the public attention is in *a high degree fixed* on the gentlemen who have been educated in the institution here alluded to; and that future years will manifest, by the improvements introduced into our arsenals, the advantages of the course of instruction they have enjoyed. They have indeed enjoyed great and eminent advantages. They have been instructed in all the essential elements of mathematical science. They have had the writings of ATWOOD, of CHAPMAN, of BOUGUER, and of many other eminent theorists, placed in a familiar aspect before them; and been taught to apply many of their maxims to actual examples. They have moreover been taught the higher uses of a calculus, which in every branch of science, to which its transcendent powers have been applied, has surmounted the greatest obstacles, and revealed in living characters the most mysterious phenomena of the universe.

With such advantages, and those which a gradually enlarging

experience must necessarily impart, we may yet hope to see naval architecture raised to its natural rank in the scale of the arts, by the *combined* exertions of the gentlemen alluded to. Nor will the grateful offerings of an enlightened people be wanting to praise and honour their attempts. A few years of uniform attention to the subject may throw on many of its elements the beams of a steady and cheering light; and in the end, the cultivators of this noble art will have the gratification of finding it no longer the sport of accident and chance, but guided by principles and rules, true and unexceptionable in their nature, and unfailing in their application; the light of a pure geometry guiding their steps in all their investigations, and crowning their labours from time to time, with new proofs of the beneficial effects which science is capable of conferring on every art to which its powers may be judiciously applied.

It may be proper in conclusion to state, that the writer of this article, *is totally unconnected with the school of naval architecture, and with our naval arsenals;* and he only now ventures his opinions on this most important subject, from having had many opportunities of witnessing the admirable union of scientific skill and practical experience possessed by many of the students sent forth by the enlighted Professor at Portsmouth; nor can he refrain from expressing his firm conviction, that the most important consequences to naval architecture may be anticipated, from the zeal and intelligence which animates them. It is, indeed, a matter for grave consideration, how far the employment of these valuable young men, as the masters of joiners and other inferior occupations, is likely to fulfil the important objects for which the institution was designed. Naval architecture is a subject which requires the "*undivided man;*" and we can only hope to see it advance with any tolerable certainty towards perfection, by giving to those who have been scientifically educated in its different branches, every opportunity for improvement which our Dock-Yards can afford.

November 27*th*, 1824. ALPHA.

Art. XIII. *Proceedings of the Royal Society of London.*

The usual meetings of the Society were resumed after the long vacation, on *Thursday, the 18th of November*, at which meeting Captain Douglas Charles Clavering was admitted, and Richard Penn, Esq. was elected a Fellow of the Society.

Dr. Babington, Sir T. S. Raffles, and Messrs. Baily, Mac Leay, and Herschel, were elected Auditors on the part of the Society.

Thursday, Nov. 25.—The Cronian Lecture was read by Sir Everard Home, Bart., in which he announced his discovery of nerves in the fœtal and maternal placenta.

His previous researches had led him to doubt the existence of blood-vessels without nerves, and the extreme vascularity of the placenta led him to suspect them in that organ. With the assistance of Mr. Bauer, therefore, he first examined the placenta of the seal, the arteries and veins of which had been injected, and in which nerves were discerned, not only surrounding the umbilical arteries, but also in the uterine portion.

In the pregnant uterus of the Tapir of Sumatra, in which, there being no placenta, the umbilical chord is connected with the Chorion, nerves were very conspicuous in the transparent portion of the Chorion along which the branches of the funis pass before they arrive at the spongy part.

Having thus proved the existence of nerves in the placenta, and where that is wanting, in the flocculent Chorion, Sir E. proceeded to offer some general remarks upon their probable uses and influences.

From the various sources, the number and the ganglia of the uterine nerves, and from the circumstance of their becoming enlarged during pregnancy, he inferred their powerful influences on the *Fœtus in Utero*; and, for the further illustration of this subject, added a description of the nerves connected with the generative organs in the human species, the quadruped, the bird, and the frog.

He concluded the lecture with remarking, that since the discovery of the placental nerves proves the existence of a communication through their medium between the brain of the child and that of the mother, some light may be thrown upon the degree of dependance in which the fœtus is kept, during the whole time of utero-gestation, and upon the influence of the bodily and mental affections of the mother upon the child; in further illustration of which, several instances were detailed in proof of the descent of various peculiarities of the mother to the offspring.

Another paper was also communicated by Sir Everard Home, entitled *Observations on the Changes the Ovum of the Frog undergoes during the formation of the Tadpole.*

The ova of the frog when in the ovaria, consist of dark vesicles, which acquire a gelatinous covering on entering the oviduct, and are completely formed by the time they reach the cavities in which the oviducts terminate, and during their expulsion from which they receive the male influence; after this the contents of the ovum, previously fluid, coagulate and expand, the central part being converted into brain and spinal marrow, while in the darker substance of the egg, the heart, and other viscera are formed.

The membrane forming the vesicles, being destined to contain the embryo when it has become a tadpole, enlarges as the embryo increases, and may be said to perform the office both of the shell and its lining membrane in the pullet's egg, serving as defence, and allowing of aëration.

The black matter which lines the vesicles, probably tends to the defence of the young animals from the too powerful influence of the solar rays, frog-spawn being generally deposited in exposed situations. Sir Everard observed, that in the aquatic salamander, an animal whose mode of breeding closely resembles that of the frog, this nigrum pigmentum is wanting, but that that animal deposits its eggs within the twisted leaves of water-plants which afford them an equivalent protection.

Thursday, Nov. 25.—A paper was communicated by W. Whewell, Esq. F.R.S., on *A general method of calculating the Angles made by any Planes of Crystals, and the Laws according to which they are formed.*

The object of this elaborate paper was to propose a new system of notation for expressing the planes of a crystal, and their laws of decrement, and to reduce the mathematical part of crystallography to a few simple formulæ of universal application. The author proposes to represent each plane of a crystal by a symbol indicative of the laws from which it results, which by varying only its indices, may be made to represent any law, and by means of which, and of the primary angles of the substance, a general formula may be derived expressing the dihedral angle between any one plane resulting from crystalline laws and any other. The angle contained between any two edges of the derived crystal may also be found in the same manner; and conversely, having given the plane, or dihedral angles of any crystal, and its primary form, the laws of decrement according to which it is constituted may be deduced by a direct and general process.

The mathematical part of this paper depends on two formulæ, by one of which the dihedral angle included between any two planes can be calculated when the equations of both planes are given; and by the other the plane angle included between any two given right lines, can in like manner be expressed by assigned functions of the coefficients of their equations supposed given. These formulæ being taken for granted, it remains to express by algebraical equations the planes which result from any assigned laws of decrement for the different primitive forms. For this purpose the author assumes one of the angles of the primitive form, supposed, in the first case, a rhomboid, as the origin of three co-ordinates respectively parallel to its edges, and supposes any secondary face to arise from a decrement on this angle by the subtraction of any number of molecules on each of its three edges. It is demon-

strated, first, that the equation of the plane arising from this decrement will be such that the co-efficients of the three co-ordinates in it (when reduced to its simplest form) will be the reciprocals of the numbers of molecules subtracted on the edges to which they correspond. If the constant part of this equation be zero, the face will pass through the origin of the co-ordinates; if not, a face parallel to it may be conceived, passing through such origin, and will have the same angles of incidence, *&c.*, on all the other faces of the crystal, so that all our reasonings may be confined to planes passing through the origin of the co-ordinates.

In order to represent any face, Mr. Whewell encloses between parathenses the reciprocal co-efficients of the three co-ordinates of its equation, with semi-colons between them. He then shews how truncations on the edges and angles of the primitive form are represented in this notation, by one or more of the elements of which the symbol consists becoming zero or negative, thus comprehending all cases which can occur in one uniform analysis.

The law of symmetry in crystallography requires, that similar angles and edges of the primitive form should be modified similarly, to produce a perfect secondary crystal. This gives rise to *co-existent planes.*

In the rhomboid, three co-existent planes are found by simple permutation of the elements of the symbol one among another. In the prism, such only must be permuted as relate to similar edges.

In other primitive forms, such as the tetraëdron, Mr. W. institutes a particular inquiry into the decrements of the co-existent planes which truncate the different angles of the primitive form, as referred to that particular angle which he assumes as the origin of the co-ordinates. In this latter case, it follows from the analysis, that each of the elements of the symbol must be combined with its excess over each of the remaining two to form a new symbol. This gives four symbols, each susceptible of six permutations, making in all twenty-four faces.

Mr. W. then considers a variety of other cases, and treats of the order in which the faces lie in a perfect crystal, and the determina-

tion of such faces as are adjacent or otherwise. Lastly, he investigates the angles made by edges of the secondary form*.

On Tuesday, the 30th of November, being Saint Andrew's Day, the Anniversary Meeting of the Society was held according to annual custom. On taking the chair, the President informed the Society that the following gentlemen had been elected into it since the last anniversary, namely,

John Bailey, Esq.,
Anthony Mervin Storey, Esq.,
Mr. Michael Faraday,
Charles Scudamore, M.D.,
Thomas Amyott, Esq.,
William Wavell, M.D.,
Rev. Edw. Maltby, D.D.,
John Jebb, Lord Bishop of Limerick,
Capt. Philip Parker King, R.N.,
Major-General Sir John Malcolm, G.C.B.,
Horatio, Earl of Orford,
Woodbine Parish, Esq.,
Sir Francis Shuckburgh, Bart.,
Edmund Henry Lushington, Esq.,
Rev. Edmund Goodenough, D.D.,
John Gage, Esq.,
Charles Mackintosh, Esq.,
Rev. William Vernon,
Lieut. Henry Foster, R.N.,
Capt. Douglas Charles Clavering, R.N.,
Rev. Baden Powell, M.A.,
Major Charles Hamilton Smith,
William Scoresby, Jun., Esq.

* In this communication, Mr. Whewell refers to a paper by Mr. Levy, who had previously, unknown to Mr. W., employed the representation of a secondary plane, by its equation referred to the three principal edges of the primitive form; but only in a particular case, whereas the investigations and notation in the present paper are absolutely general.

The President then announced the following deaths of Fellows of this Society during the last year, namely,

Carsten Anker, Esq.,
James Peter Auriol, Esq.,
George Lord Byron,
Thomas Chevalier, Esq.,
William Falconer, M.D.,
Mr. Wilson Lowry,
Francis Maseres, Esq.,
Sir Thomas Plumer, Knight,
Sir Thomas Reid, Bart.,
Rev. Thomas Rennel, D.D.,
John Walker, Esq.

On reading over this list of deceased members, the President observed that the only character which he was called upon to notice as a contributor to the *Philosophical Transactions* and an active member of the society, was that of Baron Maseres who may be considered, said Sir Humphry, as belonging to the old mathematical school of Britain, and who devoted much of his leisure and a portion of his fortune to the pursuit and encouragement of the higher departments of algebra and geometry. The President then adverted to his communications to the Royal Society, and eulogised his disinterested attachment to science as shown by his own publications, and by the liberality with which he encouraged those of others. He died in extreme old age, having almost outlived his faculties.

Following the course of the business of the day, the President announced the decision of the Council with respect to the Copleyan medal, which was awarded to the Rev. John Brinkley, D.D., Andrew's Professor of Astronomy in the University of Dublin, and President of the Royal Irish Academy, for his various communications printed in the transactions of the Royal Society.

Sir H. Davy then proceeded to state the grounds upon which the Council had awarded this token of the respect of the Society on the present occasion, pointing out Dr. Brinkley's merits as an accurate and acute observer, dwelling in detail upon his various astronomical publications, explaining his enquiries and their results as contrasted with those of other philosophers, and elucidating their interest and importance by a somewhat extended sketch of the history of astronomical discoveries.

After enumerating Dr. Brinkley's contributions to the *Philosophical Transactions*, the President observed, that of their high merits there was but one opinion among competent judges, not at home only, but (he spoke from his own immediate knowledge) likewise abroad. Alluding to the different opinions entertained by Dr. Brinkley and the Astronomer Royal, upon the subject of parallax and southern declination, Sir Humphry remarked, that while the latter denied sensible parallax, the former did not admit the existence of southern declination; and that as in awarding the medal upon a former occasion to Mr. Pond, the Council meant not to sanction his opinions, or to presume to decide upon such nice questions, so, upon the present occasion, he felt it his duty to make the same reservation, and to state that the general labours of Dr. Brinkley in the most difficult parts of astronomy, and the high merits of his philosophical inquiries, are the sole grounds on which the medal has been bestowed. "The Council," continued Sir Humphry, "could not with propriety form an opinion on these subjects, when two such astronomers, possessing such peculiar qualities for observation, and such varied and exalted resources, are at variance."

To illustrate the difficulty and delicacy of the question of parallax, the President gave a condensed view of the opinions of various astronomers respecting it, from the time of Copernicus downwards, and in enlarging on Dr. Brinkley's views and opinions, as given in his papers, especially in that last published, he again contrasted them with those of the Astronomer Royal, and more particularly explained the grounds of their differences. "Such," he then said, "is the state of these two questions; they are not, however, questions of useless controversy, or connected with hostile feelings. The two rival astronomers seem equally animated by the love of truth and of justice, and have carried on their discussions in that conciliating, amiable, and dignified manner which distinguishes the true philosopher."

After some further remarks in reference to the subject of parallax and southern declination, in which the President entered more minutely into the details of the labours of Dr. Brinkley and

Mr. Pond, he could not, he said, but congratulate the Society that the state of scientific inquiry, and the number of scientific men, rendered it scarcely possible that any great problem could long remain unsolved, or any considerable object of interest uninvestigated. No question is now limited to one observatory, to one country, or even to one quarter of the globe; whilst such men as Brinkley observe at Dublin, Bessel at Koningsberg, Arago at Paris, Olbers at Bremen, Schumacher at Altona, and Gauss and Hardinge at Göttingen, astronomy must be progressive; her results cannot but become more refined. Sir H. then gave some account of the state of astronomical science abroad, and especially in Germany, and mentioned, in terms of great approbation, the perfection with which instruments were constructed by Reichenbach and Frauenhoffer, and the zeal with which astronomical pursuits were carried on upon the continent of Europe; all which circumstances, he said, ought to be subjects of congratulation to us, not of uneasiness; and if they produce any strong feeling, it should be that of emulation and glory—the desire of maintaining the pre-eminence which, since the foundation of the Royal Observatory, has belonged to us in this science.

The President concluded his discourse nearly in the following words:—"There is, Gentlemen, no more gratifying subject for contemplation than the present state and future prospects of astronomy; and when it is recollected what this science was two centuries ago, the contrast affords a sublime proof of the powers and resources of the human mind. The notions of Ptolemy of cycles and epicycles and the moving spheres of the heavens were then current; the observatories existing were devoted rather to the purposes of judicial astrology than to the philosophy of the heavenly bodies; to objects of superstition, rather than of science. If it were necessary to fix upon the strongest characteristic of the superiority of modern over ancient times, I know not whether the changes in the art of war, from the application of gunpowder; or in literary resources, from the press; or even the wonderful power created by the steam-engine, could be chosen with so much propriety as the improved state of astronomy. Even the Athenians, the most enlightened people of antiquity, condemned a philosopher to death

for denying the divinity of the sun; and it will be sufficient to mention the idolatry or utter ignorance of the other great nations of antiquity with regard to the laws and motions of the heavenly bodies. Take," said the President "the simplest view of the science as it now exists, and what a noble subject for exultation! Not only the masses and distances of the sun, planets, and their satellites are known, but even the weight of bodies upon their surfaces ascertained, and all their motions, appearances, and changes predicted with the utmost certainty for ages to come, and even carried back through past ages, to correct the chronology and fix the epochs in the history of ancient nations: even attempts have been made to measure the almost inconceivable distances of the stars;—and with this what sublime *practical* results—the pathless ocean navigated, and in unknown seas, the exact point of distance from known lands ascertained—all vague and superstitious notions banished from the mind, which, trusting in its own powers and analogies, sees an immutable and eternal order in the whole of the universe, intended, after the designs of the most perfect Beneficence, to promote the happiness of millions of living beings; and where the whole of created nature offers its testimony of the existence of a Divine and supreme intelligence!"

The President then put the Copley medal into the hands of Mr. Baily, who undertook to transmit it to Dr. Brinkley.

The Society then proceeded to the election of the Council and Officers for the year ensuing; the statute relating to these elections was read, and Messrs. Baily, Raper, and Thompson, having been appointed Scrutators, the Members gave in their lists—on examining these the following was found to be the state of the elections:

The Members of the Old Council re-elected for the ensuing year, were

Sir H. Davy, Bart.,
W. T. Brande, Esq.,
Samuel Goodenough, Lord Bishop of Carlisle,
Major Thomas Colby,
John Wilson Croker, Esq.,
Davies Gilbert, Esq.,
Charles Hatchett, Esq.,
Sir Everard Home, Bart.,
John Pond, Esq.,
W. H. Wollaston, M.D.,
Th. Young, M.D.

The Members of the Society chosen into the Council were

Wm. Babington, M.D.,
F. Baily, Esq.,
J. G. Children, Esq.,
Viscount Dudley and Ward.,
J. F. W. Herschel, Esq.,
Capt. H. Kater, Esq.,
T. A. Knight, Esq.,
A. Mac Leay, Esq.,
Sir T. S. Raffles,
The Duke of Somerset.

Officers for the Ensuing Year.

President.—Sir H. Davy, Bart.
Treasurer.—D. Gilbert, Esq.
Secretaries. { W. T. Brande, Esq. / J. F. W. Herschel, Esq.

Thursday, Dec. 9.—This meeting was chiefly occupied with reading the minutes of proceedings on the anniversary. Three large volumes of astronomical observations made at Paramatta, in New South Wales, were received from Sir Thomas Brisbane, to whom the thanks of the Society were ordered for them.

Art. XIV. ANALYSIS OF SCIENTIFIC BOOKS.

I. *An Explanatory Dictionary of the Apparatus and Instruments employed in the various Operations of Philosophical and Experimental Chemistry ; with seventeen quarto copper-plates.* By a Practical Chemist. *London,* 1824, pp. 295.

A good Dictionary descriptive of chemical apparatus, and of the *modes of using it,* would be an invaluable acquisition to the laboratory of the young practical chemist, and if executed by a person of capability and experience, would be of infinite use to the manufacturer and artisan. But it unfortunately happens that those who are most dexterous in the management of the utensils and processes of practical chemistry, are almost always the least willing and often the least able to transfer their knowledge and experience to others through the means of the press ; indeed the communication of much of such information is often impossible; in the nicest analytical processes how much depends upon skill and tact in col-

lecting precipitates, drying, and weighing them; and how cumsy, slow, and inefficient are the proceedings of the uninitiated in those trifling mysteries, compared with the accurate rapidity and efficient delicacy of those who have acquired tact by practice!

We turned, in the Dictionary before us, to the articles "Filtering" and "precipitating Apparatus;" under the former, instead of finding an enumeration of the little practical points to which we have adverted, we are told, by way of definition, that "filtration is a *finer* species of sifting;" "that *salt* water cannot be deprived of its salt by filtration, but *muddy* water may!" p. 111. After this curious and useful information, reference is made to fig. 19, plate I., which represents a "*filtering* stand," consisting of three legs, supporting a horizontal board furnished with a hole," &c. Of the glasses for collecting precipitates every shape, except the right one, is described: "conical," it is true, they should be, but the base (and not the apex of the cone as here stated) should be downwards.

The blowpipe is a very important instrument in the hands of the experimental chemist, and Mr. Children's translation of Berzelius' Essay upon it has communicated much valuable practical information upon the subject of its use and applications; but under the article "Blowpipe," instead of a compendious abstract, which really would have been useful, of the work we have just named, there is a great deal of rhetoric wasted to prove that the cheeks, nostrils, lungs, and mouth resemble a double bellows, while all that should have been communicated to the learner respecting the various and indeed opposite effects of the different parts of the jet of flame are carefully withheld. It is true, that to make up for this defect, Mr. Gurney's oxydrogen blowpipe is described at length in three out of the two-hundred-and-ninety-five pages before us.

Under the head "Mercurial-Pneumatic Trough," not a word is said of Mr. Newman's excellent and economical form and construction of that indispensable piece of apparatus, for which we refer our readers to the First Volume of this Journal, and which, since that time, he has considerably improved.

Under the article "Pneumatic-pump," or air-pump, a description of the worst and most imperfect construction of that machine is given, to the exclusion of all the various improvements which it has lately undergone. We had hoped to have here found an account of the principle sometime since adopted by Mr. Styles, of the London Institution, by which a considerably more perfect vacuum is obtained than by any other contrivance which we have seen adopted, and of which we shall endeavour to procure a description; but the author of this Dictionary has not even noticed the pumps with glass cylinders and metal valves, as usually constructed by the best instrument-makers of Paris.

Hygrometers of various kinds are copiously and pretty correctly dwelt upon, and the author has made some amends for the intro-

duction of Mr. Leslie's lucubrations upon this subject, by an account of Mr. Daniell's hygrometer, abstracted from this Journal, (Vol. IX.) He has not, however, noticed that gentleman's pyrometer, though Mr. Wedgwood's useless and incorrect contrivance is most amply descanted on.

We might proceed to criticise various other articles of this Dictionary, but as we find much to blame, and very little to praise in any part of it, we shall decline the disagreeable task of exposing its errors and inaccuracies, and of censuring the superficial book-making propensity which appears to have presided over its compilation. Who the "Practical Chemist" may be to whom we are indebted for this addition to scientific literature we know not, but we strongly recommend him to revise his production, to reject much of the obsolete and useless matter which now fills his volume, and to replace it by that kind of practical information which, if he really be what he calls himself in the title-page, he must have at command, and which, if candidly and clearly communicated, will ensure a large sale to his work, and instead of calling for the censure of the honest and unprejudiced critic, will deserve his utmost praise and commendation.

II. *Remarks on the Different Systems of Warming and Ventilating Buildings; addressed to the Economist, the Invalid, the Desirer of Safety, and the Lovers of Comfort, with reference more particularly to an improved and simplified calorific Apparatus, constructed and introduced by* G. P. Boyce. *London,* 1824.

Mr. Boyce begins this pamphlet with remarks upon the importance of his subject, and with animadversions upon the ignorance and folly of his countrymen in adhering to the antiquated methods of warming their houses by open fires. These matters he treats with a degree of erudition and pointed satire, which remind us of the long-lost style of Addison and Swift. "That the present mode of obtaining warmth," he says, "is defective in an eminent degree, every one, however, unwilling to confess himself in error, must be innately conscious. A more bungling and inefficient process was, perhaps, never devised, than that by which it is attempted to raise the temperature of an apartment by means of an open fire in a grate and chimney of the modern construction; nine-tenths of the heat produced by the one, being, from the very nature of things, immediately carried off through the channel of the other; and the remaining tenth, slowly communicated to the air of the apartment, is just sufficient to convert every aperture and crevice into a trap for colds, fevers, rheumatism, and all the disorders arising from checked perspiration. Talk of the comforts of an English fire indeed! it is a pitiful mockery: there is not a nation on earth, between this latitude and the Pole, (for with the inhabitants of

Southern Europe, of course we can draw no parallel,) but knows more of the comforts of a fire, than England does. Germany and Russia, our two great competitors, have long been possessed of superior winter comforts to ourselves; and even the poor diminutive beings within the Arctic Circle, contrive, by means of a few heated stones, and a half-buried hut, to procure more of the real enjoyment of warmth, than an Englishman, with all his boasted dexterity in art, has ever been able to command. In order to put this part of the subject in its proper light, it is only necessary just to trace, by way of illustration, the history of *English fire-side pleasures*, through the period of a December day," pp. 11, 12.

We have often, with this writer, admired the real enjoyment and comfort of an Esquimaux hut, as described by Captain Parry, and have been surprised that the ingenious mode of warming it by heated stones and burning blubber has never found its way into our drawing-rooms; but the fact is, as Mr. Boyce elsewhere deplores, that we are woefully bigotted to ancient usages. Our author then proceeds, in the same strain of eloquent gaiety, to expatiate upon the miseries of the bed-room and breakfast-parlour. It would be injustice to our readers to resist the quotation.—"The first sensationof which you areconscious, on awaking, is that it is 'a bitter cold morning;' and, with an anxious look at the frosted panes, and a glance at the empty grate, you flatter yourself that, by dressing very expeditiously indeed, you may yet indulge for another half-hour, in the enjoyment of your comfortable dormitory; but time flies quickly with the happy! and when you are really risen, you find that a full hour of the day is passed, which no after-exertion can absolutely recover. At length, quite dressed, and half frozen, you descend to the breakfast parlour, and, with all the impatience of long repressed desire, rush, shivering and open handed, to the bright, sparkling, happy looking fire-side. The first greetings of this loved object are not, however, quite so kind as might be wished; for in a few moments, you begin to feel the effects of the sudden transition, in a tingling sensation about the extremities of your swelling fingers, till, as if by a torpedo shock, you find your power over them gone; while the exquisite pain, conquering all ideas of dignity, sends you dangling them, and dancing in agony round the room." p 13.

It will easily be understood that a gentleman gifted with the literary acumen displayed in the above quotations, is not likely to waste his time and talents upon the minutiæ of mechanical details; he accordingly tells us that he has contrived a stove for heating houses, not liable to many of the disadvantages of those in common use, the construction of which it would be superfluous to describe, as all particulars respecting it may be learned at No. 57, Connaught Terrace, Edgware Road.

But although Mr. Boyce has not enabled us to explain the principles of his discovery or the construction of his apparatus, there

are writers upon this subject who have been more communicative, and as it is one of extreme importance and excessively neglected, a few plain and simple details respecting it may not be altogether unacceptable at this season of the year. We shall be as brief as possible.

There are two stoves now in very general use for warming houses, churches, and other buildings, which appear to us preferable to most other contrivances of the kind; they are neither difficult in their application, nor very complex in their construction, and as their inventors have fully described both, and are without the monopoly of a patent, we cannot well be accused of any unjust partiality in recommending them.

The first of these which we shall notice, as being the cheapest and simplest, is the invention of Mr. Perkins, and is described in the 38th and 39th volumes of the *Transactions of the Society of Arts.* There are two forms of it; one calculated for halls and workshops, consists of a circular iron-stove, immediately at the back of which is introduced a large column of cold air, by which means the radiant heat from the stove is rapidly carried off. The channel by which the cold air is admitted is so contrived as to spread it over the greater part of the heated-iron surface, and afterwards rapidly to diffuse it over the room. In this form of the stove the smoke is supposed to be carried off either directly into a chimney, or by an iron-pipe. In the other form of Mr. Perkins' stove, the iron-pipe by which the smoke is conveyed is made the principal source of heat; it is carried perpendicularly upwards, and surrounded by a vertical air-trunk fitted in proper places with sliding registers, by which the current of hot air may be checked in its passage upwards, and directed by side apertures into any particular apartment. The current of cold air beating against the stove is admitted as before; but, instead of being suffered to diffuse itself below, it is received by the funnel-shaped aperture of the air-shaft, and carried upwards for distribution. A stove of this kind has been applied with considerable advantage for warming the amphitheatre of the Royal Institution, and though circumstances do not there admit of its most favourable application, it effects its purpose very satisfactorily. It is obvious that in certain situations the chimney, and its surrounding air-shaft, may be carried up outside a house, and that the hot air may be thrown into the building by one or more side apertures. The stove may either be of the common construction, or so contrived as to have a descending draught of air passing through the fuel, by which the smoke is burned, and the accumulation of soot in the iron chimney to a great extent prevented.

Mr. Perkins' plan is recommended by its simplicity, cheapness, and facility of general application, but it has several disadvantages; the heated air is readily contaminated by any dirt or dust

that happens to fall upon the stove, and it always has more or less of a burnt odour, arising from the necessarily high temperature of the surface of iron over which it passes, and from which it receives its supply of heat. We also have doubts of its safety in certain situations.

Of Mr. Silvester's system of heating and ventilation, we can speak with less equivocal praise; but, it is much more expensive, and owing to the stupidity of architects and builders, more difficult of application. A description of it will be found in the inventor's account of the Derbyshire General Infirmary *, with drawings illustrative of its construction. We must satisfy ourselves here with a brief account of the principles of the contrivance.

It is necessary that the stove should be erected on the basement story, or, if possible, below it. It consists of a square wrought-iron cockle, in the interior of which is the fire, and which is surrounded by brick-work of the same shape, there being a space of about six or eight inches left between the cockle and brick-work. The air to be heated is brought from without, and conveyed by a number of tubes which pass through the lower half of the brick-work and terminate within less than an inch of the cockle, and it is discharged through a similar set of tubes, which perforate the upper half of the brick-work, and terminate in what is called the hot-air chamber, a cavity from which an upright flue issues to carry the heated air to its destination. The cold air, therefore, is twice brought close to the heated cockle, first, upon its entrance, and then upon its exit, and it is never made very hot, but a *very large quantity of moderately-heated air* is driven up the air-shaft or flue; the air never, as far as we have perceived, has any disagreeable smell, nor can it, in consequence of the construction of the fire-place, be at any time over-heated. We have remarked the necessity of placing this stove considerably below the rooms or hall and staircase to be heated; from fifteen to twenty, or even thirty feet, is desirable where it can be obtained, in order to ensure a rapid current; for the velocity of the heated air is not only as its temperature, but also as the square root of the height. Matters should be so adjusted in this respect, as not to suffer the heat of the cockle to exceed on any occasion 300°.

Whenever stoves of the description we have described, are employed for heating rooms, or close apartments of any kind, effectual means should be at the same time resorted to, to secure a perfect

* The Philosophy of Domestic Economy, as exemplified in the mode of warming, ventilating, washing, drying, and cooking; and in various arrangements contributing to the comfort and convenience of domestic life, adopted in the Derbyshire General Infirmary; and more recently on a greatly extended scale in several other public buildings newly erected in this country; together with an explanation of the principles on which they are performed. By C. Silvester, Engineer. 1819. Longman.

ventilation. This is very well effected by a common open fire, which is desirable in all private houses, not merely on account of its *comfort*, but also for the above purpose; we by no means recommend the exclusion of common fires, but merely not to depend upon them exclusively for the heat of our apartments. In general we are obliged to rest content with warming the great mass of air in the hall and staircase, and trusting to its diffusion through the rooms, but if architects and builders (a very *irritable ràce*, by the way, and monstrously unwilling to be set right) would merely leave in every house a provision, in the form of a spare flue or two, for the conveyance of heated air, (it might be used or not) all the clumsy adaptations and dangerous make-shifts, to which we are now compelled to resort, when desirous of warming a house by a hot-air stove, would be effectually avoided.

In speaking of Mr. Silvester's stove, we should rather have called it Mr. Silvester's improvement of Mr. Strutt's stove, for it has been in use upwards of thirty years at Messrs. Strutt's cotton-mills at Belper, near Derby. Mr. Silvester himself observes, that it was there open to the inspection of any inquirer, and yet, until he brought it into notice and improved it, was scarcely in any other case adopted, notwithstanding the most convincing proofs of its excellence and economy; in this stove, however, the brick-wall which surrounds the cockle, and which we have described as perforated by tubes for the entrance of the cold and egress of the heated air, was without tubes, and merely had square holes in it for the same purpose; the mere addition of the tubes was found to produce *double the effect with the same fuel.*

We had intended to have said something upon the subject of heating by steam, but its want of economy, and the great comparative difficulty of carrying it into execution, except in reference to particular situations, prevents our recommending it for private dwelling-houses: to these our observations are now intended chiefly to apply, and if they shall be the means of inducing those who are concerned to take the matter into their consideration in building new houses, and in erecting public edifices, the object of this article will be attained. If our readers wish for an example of a well-warmed and ventilated building upon a large scale, we are sorry that we have none nearer at hand than the Derby Infirmary; if they wish for a sample of an ineffective attempt, dangerous, dusty, and in every respect dissatisfactory, let them visit the British Museum on a cold December day. May things may be mended in the new building!

Art. XV. ASTRONOMICAL AND NAUTICAL COLLECTIONS.

No. XX.

i. *Example of the Correction of a* Lunar Distance, *computed by means of Mr.* David Thomson's *Lunar and Horary Tables.*

In the Nautical Almanac for 1825, the example employed in illustration of the excellent method of computation, published in the Appendix to the Requisite Tables, stands thus corrected:

	° ′ ″		′ ″				
☽'s Hor. Par.	59 27						
☉'s App. Alt.	59 11 52	−	0 30	51 46	Correction of Difference.		
☽'s App. Alt.	26 34 41	+	51 16				
Diff. of App. Alt.	32 37 11	N. vers.		157733	Table IX.	9.996819	
App. Distance	59 25 34	N. vers.		491351	Table X.	16	
					Res. Log.	9.996803	
		Difference		333618	Logar.	5.523250	
		Nat. n.		331172	Logar.	5.520053	
Diff. of True Alt.	31 45 25	N. vers.		149712			
True Distance	58 43 37	N. vers.		480884			

By Mr. Thomson's Tables, the result is obtained much more expeditiously. Thus:

	° ′ ″				
☽'s Hor. Par.	59 27	Tab. Log.	0.0211	. . . .	0.0211
☉'s App. Alt.	59 12	. . .	0.5260	☽'s App. Alt. 26° 35′	0.8092
App. Distance	59 25 34	L. S.	0.9350	. L. T. . . .	1.2286
First Corr.	4 0 41	. . .	1.4821	Sec. Corr. L.	2.0589
Second Corr.	5 15 43				
Third Corr. T. XVIII.	1 40				
Sum less 10°	58 43 38, the true distance, within 1″.				

The following comparative results will sufficiently show that Mr. Thomson's tables agree in general with the direct methods of computation as nearly as can be desired.

True Distance. ° ′ ″	Mr. Thomson. ° ′ ″
43 31 1	43 31 5
103 3 18	103 3 19
51 9 50	51 9 53
96 52 3	96 52 3
63 53 17	63 53 18
45 1 47	45 1 46

True Distance.	Mr. Thomson.
° ′ ″	° ′ ″
50 26 28	50 26 28
41 18 54	41 18 56
86 16 45	86 16 44
33 56 49	33 56 49
55 32 42	55 32 42
60 14 44	60 14 43
107 17 13	107 17 14
30 11 29	30 11 26

When it is considered that these tables of Mr. Thomson occupy less than ninety octavo pages, and that the work of Mendoza is nearly out of print, it cannot be doubted that many navigators, who wish to spare their labour, will become purchasers of this volume.

ii. *Comparison of the Astronomical Tables of* Carlini *and of* Coimbra *with those of* Delambre *and* Burckhardt.

In a little work entitled *Esposizione di un nuovo metodo di costruire le tavole astronomiche, applicato alle tavole del sole, di Francesco Carlini;* 8. Milan, 1810, published also with the Efemeridi di Milano, the author has introduced a very valuable simplification of the process of taking out the respective arguments of the equations of his tables, by making a mean solar day the unit of each; so that the epoch and arguments being found for the year only, the time is only to be added to each in days and parts of a day, without the necessity of taking out separate "movements" for each separate argument, as is usual in all the more common tables. The comparative facility afforded by this arrangement will be best illustrated by an example taken from Delambre's tables, sheet *h*, which is the same that Carlini has exhibited.

The diligent astronomers of *Coimbra* have given, in a very neat and compact form, a collection of tables for the sun, moon, and principal planets, arranged in general so as to require single entries only, which lengthen in a slight degree the apparent length of the process, though they render it simpler and more convenient. But for the moon they have given also a method considerably more compendious, in which double entries are employed for shortening the computation. The same example of a place of the sun is here subjoined, as determined by these tables also.

Calculation of the Sun's Longitude, from Delambre.

	Longitude	Perigee	*M*	*A*	*B*	*C*	*D*	*E*	*F*	*N*
Sec. Eq.	0,4	0								
1805	9.10.11.2,8	9. 9.34.13	593	984	278	530	304	649	512	176
13 Nov.	10.11.27.52,3	54	468	705	865	406	460	73	29	46
	7.21.38.55,5	9. 9.35. 7	061	689	143	936	764	722	541	222
15^H	36.57,7	7.22.18. 1		33	2	3				
51^M	2. 5,7	10.12.42.54	=	722	145	939				
49",8	2,0	10.12.42,90	=	22						
	7.22.18. 0,9	10.12.715 m. an.		744						

Eq. centr.	11.28.33. 8,8
For 2′	2,7
For 0′,9	1,2
Sec. Var.	— 0,5
A	0,0
2d and 3d pts.	0,4
B.C	11,0
B.D	8,0
B.E	11,3
B.F	0,8
⊙ M. Eq.	7.20.51.44,6
Lun. N. +	17,7
Sol. N. —	0,9
Aberr. —	0,2
⊙ Tr. Eq.	7.20.52.1,2

Carlini, for Milan, Nov. 13, 4^H 19^M $14^s,8$

	A	*B*	*C*	*D*
1805	2.10100	29.19	241	1198
Days	317.18003	317.18	317	317
	319.28103	346.37	558	1515

Diff. T. III.	362″.9
.8	290.32
.01	3.63
.0003	.12
Prop. p.	294.07
Var. −5 × .30 =	−1.5
	4′.52″,6

$E = 14.76$
$F = 25.05$
$G = 25.29$
$H = 0.6$

	310d	320d
Eq. 5	6.6^s	7.7^s
6	7.3	9.1
7	7.2	7.2
8	.9	1.0
Sum	22.0	25.0

	s.	°	′	″
1805 ⊙ Const. t.	9	9	33	27.2
Eq. 1. Argt. 319.2	10	11	12	40.3
Prop. p. and v.			4	52.6
Eq. 2				.1
3				.9
4				35.7
5, 6, 7, 8				24.1
True Longitude	7	20	52	0.9

From the Taboas Astronomicas de Coimbra, by MONTEIRO, 4. 1813.

Nov. 13, 3^{H} 8^{M} $53^{S}.8$

	⊙ A	B		C	D	E	F	G	H	I	K
Date	s. ° ′ ″	°	°	°	°	°	°	°	°	°	°
1805	9.10.42.383	1.136	188.6	227.1	262.5	115.5	91.7	350.7	170.7	49.2	164.3
Nov.	9.27.38.207	299.622	106.0	274.5	262.7	249.3	187.4	140.3	75.2	25.2	19.0
13 d.	11.49.666	11.827	146.3	10.8	10.4	9.8	7.4	5.5	2.9	1.0	0.8
3 h.	7.392	.123	1.5	152.4	175.6	14.6	286.5	136.5	248.8	75.4	184.1
8 m.	0.329	.005	0.1								
53.8 s.	.037	312.713	82.5								
M. L.	7.20.18.014										
Eq. centr.	31.995	∴ Eq.	0′.047	0′.090	0′.062	0′.056	0′.172	0′.120	0′.048	0′.132	0′.057
	.950										0.784
	.014									Sec. v. –	0.009
	.004										0.775
Pert.	.775										
	7.20.51.752										
True Long.	s. ° ′ ″ 7.20.51.45,12										

The difference may be partly owing to the difference of the supposed longitudes of Paris and of Coimbra; but it is of no importance to the comparison of the modes of computation.

iii. *Rules for computing an observed* OCCULTATION. *From the Nautical Almanac for* 1827.

Dr. YOUNG's *Method.*

I. OBSERVE, if possible, the difference of apparent altitudes at the time of immersion or emersion; or at least the altitude of the moon, the altitude of the star being computed from the true latitude of the place.

Example:—Supposing the immersion of 9 ♒ to be observed at Greenwich, the 5th of Jan. 1824, at $3^h\ 46^m\ 50^s$, the moon's altitude, corrected for refraction, being 29° 15′ 37″: we have for the declination of the star 8° 39′ 17″, that of the moon being 7° 47′ 12″ at the observed time, and the difference of declination, from the elements in the *Nautical Almanac*, 55′ 31″: the moon's right ascension, $22^h\ 7^m\ 2^s$, that of the star being $22^h\ 7^m\ 32^s$: the sun's right ascension, $19^h\ 2^m\ 19^s$; the star's less the sun's, $3^h\ 5^m\ 13^s$, which, deducted from $3^h\ 46^m\ 50^s$, gives $41^m\ 37^s$ for the star's horary angle. With these elements we proceed to compute the altitude of the star.

✳'s Log. rising		41′ 37″	3.21594
Log. cos. declination		8° 39′ 17″	9.99503
cos. Lat.		51 28 40	9.79436
n. n.	1012		3.00533

N. S.	49800	Mer. Alt.	29° 52′ 3″
N. S.	48788	Alt. ✳	29 12 5
		Obs. Alt. ☽	29 15 37
		Difference	3 32
		☽'s Par. in Alt.	47 9
		Diff. tr. Alt.	50 41

II. Having found the difference of the true altitudes from the difference of the apparent altitudes combined with the parallax of the moon, add together the squares of the semidiameter, properly augmented, and of the difference of the true altitudes, and subtract

the square of the difference of the apparent altitudes, the remainder being the square of the true distance.

Example:—The semid. .	. 14′ 54″	= 894,	sq. .	799236
Diff. true alt.	. 50 41	=3041,		9247681
Diff. app. alt. .	3 32	= 212,	A. C.	99945056
True dist. .	. 52.42,6=3162.6			10001973

III. From the difference of declination at the conjunction, reduced in the ratio of the radius to the sine and cosine of the orbital angle, we obtain the nearest distance of the star from the orbit, and the distance of the nearest point of the orbit from the point of conjunction in right ascension; or, in the *Nautical Almanac* for 1827, and the succeeding years, we find these arcs already computed. The square of the nearest distance, subtracted from that of the true distance, gives the square of the orbital distance from the point of nearest approach, which converted into time from the moon's hourly motion, and applied to the time of the nearest approach, shows the true time of the immersion for the meridian of Greenwich.

Example:—Nearest distance	50′ 31″=3031″	sq.	9186961
True distance	. . . .	sq.	10001973
Dist. from n. point	15′ 2″,8=902.8	sq.	815012

Now the hourly motion being 29′ 42″, the distance 15′ 2″,8 becomes equivalent to 30^{m} 24^{s}, and the time of nearest approach being 3^{h} 17^{m} 1^{s}, the time of immersion at Greenwich becomes 3^{h} 47^{m} 25^{s}, instead of 3^{h} 46^{m} 50^{s} as supposed; and the error of observation, or of computation, would be 35^{s} of time.

Mr. HENDERSON's *Improvement on Dr.* YOUNG's *Method.*

When neither of the altitudes has been observed, the computation of that of the moon is liable to considerable uncertainty, as depending upon the supposed longitude by account; and Mr. THOMAS HENDERSON, of Edinburgh, has remarked, that the method proposed by Dr. YOUNG does not exhibit so rapid a tendency to converge to the true longitude as would be desirable. He has therefore

proposed to substitute the reduction of the parallax to the moon's orbit, as employed by Dr. Young in the calculation of a predicted occultation, and as explained in the following Rules:

I. Compute the altitude of the star for the time of observation, and from the reduced or geocentric latitude of the place, as shown in the *Nautical Almanac* for 1826, Add. P. 1; and find the parallactic angle P ✳ Z, the sine of which is equal to the secant of the altitude multiplied by the cosine of the reduced latitude, and by the sine of the horary angle: this angle having the sign + before the star has passed the meridian, and − afterwards. The complement to 90° of the moon's orbital angle P ☽ ☽′ is to have the sign −, when the moon's nearest approach to the star and the orbital angle have the same denomination N. or S., and + when they are of different denominations. The sum of these two angles is the complement of the parallactic orbital angle Z ☽ ☽′, or the complementary angle, with its proper sign.

Example:—In the case of 9 ♒, the star's reduced altitude has been found 29° 22′ 48″, N. A. 1826. Add. P. 7; then,

Log. sec. alt. . . .	0.05979	Orb. A. . .	65° 29′ N.E. ☽ N.
cos. red. lat. . .	9.79609	Compl. .	−24 31
sin. H. A. . .	9.25669	Par. A. .	− 7 27 ✳ W. of Mer.
sin. Par. A. 7° 27′	9.11257	C. P. O. A.	−31 58

Remark 1. The parallactic angle must always be reckoned from that pole of the equator, which is either north or south, accordingly as the nearest approach is marked N. or S. in the Elements of the Occultation; and therefore, when this pole is of a contrary denomination to that of the latitude of the place, the parallactic angle is to be taken obtuse, or equal to the supplement of the angle found by the above rule. But when the latitude is less than the star's declination, and of the same denomination, an ambiguity may arise, respecting the magnitude of the parallactic angle, in proceeding by the rule above. This ambiguity may be removed by resolving, according to the common rules of spherical trigonometry, the triangle P ✳ Z, formed by the reduced zenith, the star, and the proper pole of the equator.

2. It may sometimes happen that the complementary angle exceeds 180°: in this case its supplement to 360°, with the sign reversed, is to be used.

II. Add together the proportional logarithm of the moon's reduced horizontal parallax, the logarithmic secant of the star's altitude, and the logarithmic cosecant of the complementary angle; the sum will be the proportional logarithm of the orbital parallax, which must have the same sign as the complementary angle. To this logarithm add the logarithmic tangent of the complementary angle; the sum will be the proportional logarithm of the perpendicular parallax, which must have the contrary sign to that of the moon's nearest approach, when the complementary angle is less than 90°, and the same sign when it is greater; considering + as belonging to the moon's distance, when she is N. of the star, and —when S.

Example:—The P. L. of the reduced horizontal parallax is 5225. (See N. A. 1826. Add. P. 4.)

P. L. red. H. P.			.5225
Log. sec. Alt.			.0598
cosec. compl. A.			.2762
P. L.	— 24′ 56″	O. P.	.8585
Log. tan. comp. A.			9.7952
P. L.	— 39′ 57″	P. P.	.6537

III. The sum of the moon's nearest approach and the perpendicular parallax may be considered as one of the sides, and the moon's semidiameter, without augmentation, as the hypotenuse of a right-angled plane triangle, of which the other side is to be ascertained: it will have the sign + in the case of an immersion, and — in that of an emersion. The sum of this quantity and the orbital parallax being reduced to time, by means of the moon's horary motion, and then applied to the time of observation by addition or subtraction, accordingly as it bears the sign + or —, will give the time of the nearest approach, reckoned according to the meridian of the place

of observation, which being compared with the time of the same phenomenon for Greenwich, as given in the Ephemeris, the longitude of the place from Greenwich will be obtained.

Example:—Nearest distance . .	$+ 50' \; 31''$		
Perpendicular Par. . .	$- 39 \; 57$		
Sum	$+ 10 \; 34$		
Semidiameter . . .	$14 \; 46$		
Sum	$25 \; 20$	P. L.	8516
Difference	$4 \; 12$	P. L.	1.6320
			2)2.4836
Side	$+ 10 \; 19$		1.2418
Orbital Par.	$- 24 \; 56$		
	$- 14 \; 37$		

The space 14′ 37″, reduced into time, at the rate of 29′ 42″ for an hour, gives us $29^m \; 32^s$ to be subtracted from $3^h \; 46_m \; 50^s$, the time of the immersion, and makes $3^h \; 17^m \; 18^s$ for that of the nearest approach, differing 17^s from the solar time at Greenwich.

iv. *Error in a Table of Logarithms.*

In tables that are to be used without time for consideration, the slightest errors deserve to be made generally known. The number 8814 is printed 6814 in Lalande's pocket tables, *édition revue par M. Regnaud*, Paris, 1818.

v. *Historical Sketch of the various Solutions of the Problem of* Atmospherical Refraction, *from the time of Dr.* Brook Taylor, *to that of the latest computations.*

In justice to the claims of departed merit, it is often necessary to revert to the first steps by which the inventions of modern mathematicians have been prepared, if not anticipated: but it seldom happens that the earlier solutions of a problem have been so completely forgotten as appears to be the case with the investigations of Dr. Brook Taylor respecting the path of light in the earth's atmo-

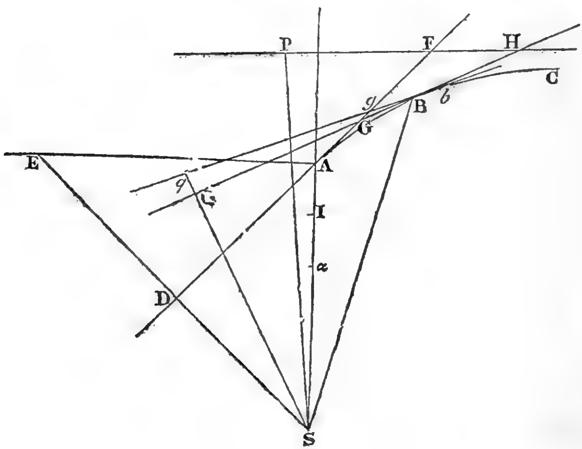
sphere. Besides having apparently furnished to Newton an instrument with which he has dazzled the admiring gaze of some later philosophers, they exhibit also a remarkable specimen of a mode of analysies which seems to afford a general if not a universal rule for the integration of any given fluxion by induction: that is, to find a series of successive *fluxions* of the given fluxinoal quantity, and to express the relation of each term of this series to the preceding one in a general formula, which being applied to the first term, or to the fluxion itself, must naturally afford us the *fluent* required.

Part I. Brook Taylor, Newton, Simpson, Kramp, *and* Laplace.

Translation of the 27th and last Proposition of Taylor's Methodus Incrementorum, 4. Lond. 1719. P. 108.

Prop. XXVII. Probl.

To find the refraction of the light passing through the earth's atmosphere.



Let S be the centre of the earth, and ABC the ray of light, of which AG and BG are tangents in A and B, meeting in G; and let SD, SQ, be perpendicular to the tangents; join SA, SB, and let AE, perpendicular to SA meet SD in E. Let the point A be supposed fixed, while the place of B is variable; and call SA $= a$, SB $= b$, SE $= t$, $\left(= \frac{aa}{b}\right)$, SB $= x$, d the density at A, and y the density in B.

Now the curvature of the ray depends on the attractive force of refraction .. which is always directed towards the greater density, that is, towards the centre of the earth ..; consequently the curve is of the nature of a trajectory produced by a centripetal force.

But the velocity of the light in A is to its velocity in B, (by the Lemma) as $\sqrt{(1+d)}$ to $\sqrt{(1+y)}$: consequently SQ : SD $= \sqrt{(1+d)} : \sqrt{(1+y)}$ (Cor. 1, Prop. 1, Book I. Princ. Math.); whence SQ $= \frac{\sqrt{(1+d)}}{\sqrt{(1+y)}} b$, and BQ $= \sqrt{x^2 - \frac{1+d}{1+y} b^2}$. When therefore the point B becomes infinitely distant, and y may be considered as vanishing, the perpendicular to the tangent, now become an asymptote, will be $\sqrt{(1+d)}\, b$. We may suppose PH to be that asymptote, meeting the tangents AG, BG, in F and H, and SP to be perpendicular to it.

Suppose now the tangent BG to be removed to a new place, bg, very near the former, and let bg meet the perpendicular SQ in q. The nascent angle gBG will then be [as] the fluxion of the angle FGH, or FHG; that is, when x increases, it will be the elementary increment of the angle FGH, and the decrement of FHG, because the angle at F is given: and, for the radius $= 1$, the arc proportional to the nascent angle QBq is $\frac{\text{Qq}}{\text{QB}}$. But Qq is [as] the fluxion of SQ, or of $\sqrt{\frac{1+d}{1+y}}\, b$, which is $\frac{1}{2}\dot{y}\sqrt{\frac{1+d}{(1+y)^{\frac{3}{2}}}}\, b = \frac{aay\dot{x}\sqrt{(1+d)}}{2cx^2(1+y)^{\frac{3}{2}}}\, b$, since $\dot{y} = \frac{-aay\dot{x}}{cxx}$, [that is, allowing for the decrease of gravity in the proportion of a^2 to x^2, and taking c for the modulus of the atmo-

spherical elasticity, which is here made $= \frac{1}{760}$, the earth's radius being unity. P. 105]. Hence $\frac{\mathrm{Qq}}{\mathrm{QB}}$, the element of the angle EGH is represented by $\frac{aaby\dot{x}\sqrt{(1+d)}}{2cxx(1+y)^{\frac{3}{2}}\sqrt{(x^2-\frac{1+d}{1+y}b^2)}}$, or by

$$\frac{aaby\dot{x}}{2cx^2(1+y)\sqrt{\left(\frac{1+y}{1+d}x^2-b^2\right)}}.$$

The angle FGB will therefore be given when the fluent of this expression is found by the inverse method of fluxions. But the angle GBS is given from the value of the perpendicular SQ, and SDG is a right angle; hence the angle DSB will be given. So that from the given distance SB, $(=x)$, the density as B, $(=y)$, and the angle SAD, [the apparent zenith distance,] the line SB will be given in position, and consequently the point B will be given, and the figure of the whole refracted ray ABC will be determined. Which was to be found.

But the fluent of $\frac{aaby\dot{x}}{2cx^2(1+y)\sqrt{\left(\frac{1+y}{1+d}x^2-b^2\right)}}$ is incapable of being expressed in finite terms. We must therefore find a series in order to compute the atmospherical refraction for astronomical purposes. Now, in order to reduce the fluxion to the simplest possible form, we may write $\frac{aa}{z}$ for x, and it will become

$$\frac{-by\dot{z}}{2c(1+y)\sqrt{\left(\frac{1+y}{1+d}\frac{a^4}{zz}-b^2\right)}} = \frac{-yz\dot{z}}{2c(1+y)\sqrt{\left(\frac{1+y}{1+d}\frac{a^4}{d}-z^2\right)}},$$

that is, neglecting the sign, $\frac{yz\dot{z}}{2c(1+y)\sqrt{\left(\frac{1+y}{1+d}tt-zz\right)}}$, $\dot{y}$ being also $=\frac{y\dot{z}}{c}$, [since $\dot{y} = \frac{-aay\dot{x}}{cxx}$, and $\dot{z} = \frac{-aa\dot{x}}{xx}$]. But at the

surface of the earth, where $y = d$, the fluxion proposed becomes $\frac{y\dot{z}z}{(2c + 2cd)\sqrt{(tt - zz)}}$; and at an infinite distance, where the fluxion itself vanishes, it does not differ one thousandth part from this value: so that neglecting this slight inaccuracy, we may safely take for the fluxion $\frac{y\dot{z}z}{(2c + 2cd)\sqrt{(tt - zz)}}$, and omitting the constant coefficient $\frac{1}{2c + 2cd}$, we may proceed to take the fluent of $\frac{y\dot{z}z}{\sqrt{(tt - zz)}}$ by means of the 11th proposition [that is, The fluent of $\dot{r}s$ is $= rs - \overset{\prime}{r}\dot{s} + \overset{\prime\prime}{r}\ddot{s} - \ldots = \dot{r}\overset{\prime}{s} - \ddot{r}\overset{\prime\prime}{s} + \ldots$; the accents denoting the fluent of the quantity marked, when combined with a constant fluxion $\dot{w}$, considered as unity.]

For $\sqrt{(t^2 - z^2)}$ write x; then $\dot{x} = \frac{-z\dot{z}}{x}$, and the proposed fluxion will be $\frac{y\dot{z}z}{x} = -y\dot{x}$, $\dot{y}$ being also $= \frac{y\dot{z}}{c}$: consequently in Proposition 11, we have $\dot{r} = y\dot{z}$, $s = \frac{z}{x}$, $\dot{w} = \dot{z} = \frac{-x\dot{x}}{z}$. Then, taking the fluxions, and dividing them continually by $\dot{w}$, we have

$$\dot{s} = \frac{z^2}{x^3} + \frac{1}{x} = \frac{tt}{x^3}, \ddot{s} = \frac{3z^3}{x^5} + \frac{3z}{x^3} = \frac{3ttz}{x^5}, \dddot{s} + \frac{15z^4}{x^7}$$

$$+ \frac{18z^2}{x^5} + \frac{3}{x^3} = \frac{15ttzz}{x^7} + \frac{3tt}{x^5} \ldots, \text{ and so forth, } \overset{n\cdot}{s} \left[\text{or } \frac{d^n s}{dw^n}\right]$$

$$\text{being} = A\frac{z^{n+1}}{x^{2n+1}} + B\frac{z^{n-1}}{x^{2n-1}} + C\frac{z^{n-3}}{x^{2n-3}} + \ldots$$

$$\text{or} = t^2 \;\text{A}\frac{z^{n-1}}{x^{2n+1}} + \text{B}\frac{z^{n-3}}{x^{2n-1}} + \text{C}\frac{z^{n-5}}{x^{2n-3}} + \ldots$$

For the investigation of the coefficient A, B, C . . denoting the preceding values of n by $n^{\backprime}, n^{\backprime\backprime}, n^{\backprime\backprime\backprime}$, and the succeeding values by $n_{\prime}, n_{\prime\prime}, n_{\prime\prime\prime}$, and taking the fluxion of the series, first with respect to x, and then with respect to z, and dividing the results continually by $\dot{w}$, we shall have

$$\overset{n_{\prime}}{s} = (2n+1)A\frac{z^{n_{\prime}+1}}{x^{2n_{\prime}+1}} + \left.\begin{matrix}(2n-1)B\\ +(n+1)A\end{matrix}\right\}\frac{z^{n_{\prime}-1}}{x^{2n_{\prime}-1}} + \left.\begin{matrix}(2n-3)C\\ +(n-1)B\end{matrix}\right\}\frac{z^{n_{\prime}-3}}{x^{2n_{\prime}-3}}$$

$$\left.\begin{matrix}+(2n-5)D\\ +(n-3)C\end{matrix}\right\}\frac{z^{n_{\prime}-5}}{x^{2n_{\prime}-5}} + \ldots$$

Hence the new A appears to be $(2n+1)A$; and A is always formed by the continual multiplication of the terms 1, 3, 5, 7 ... of which the last and greatest is $2n-1$: and if we put m for $2n-1$, we shall have $A_{\prime} = m_{\prime}A$.

From the second term also we have $B_{\prime} = mB + n_{\prime}A$. Supposing B to be obtained from A by multiplication and division, we may put $B_{\prime} = \frac{Q}{R}A$: hence $B = \frac{Q_{\prime}}{R_{\prime}}A_{\prime} = \frac{Q_{\prime}}{R_{\prime}}m_{\prime}A$. Consequently $\frac{m_{\prime}Q_{\prime}}{R}A$ $= \frac{mQ}{R}A + n_{\prime}A$, and [since $Q_{\prime} = Q + \dot{Q}$, that is, $= Q + \Delta Q$], $\frac{m_{\prime}Q}{R_{\prime}}$ $+ \frac{m_{\prime}\dot{Q}}{R_{\prime}} = \frac{mQ}{R} + n_{\prime}$. "In order to reduce this equation to the simplest possible terms, I suppose $\frac{m_{\prime}Q}{R_{\prime}} = \frac{mQ}{R}$, that is, $\frac{m_{\prime}}{R_{\prime}} = \frac{m}{R}$: hence $\frac{m_{\prime}}{R_{\prime}}\dot{Q} = n_{\prime}$: But $\frac{m_{\prime}}{R_{\prime}}$ is a new value of $\frac{m}{R}$, consequently $\frac{m}{R}$ is a given quantity and $R = m$, and hence $\dot{Q} = n_{\prime}$; and by taking the integrals of the finite differences, $Q = \frac{1}{2}n_{\prime}n + p$: but since $B = 0$ when $n = 0$, we have $p = 0$, and $Q = \frac{1}{2}n_{\prime}n$: whence $B = \frac{n_{\prime}n}{2m}A$; and $B_{\prime} = \frac{mn_{\prime\prime}}{n}B$." [It is not very easy, at first sight, to perceive the propriety of making first $\frac{m_{\prime}}{R_{\prime}} = \frac{m}{R}$, and then $R = m$, though it was most consistent with the author's analytical system to adopt these steps, and the next paragraph will show their utility: but it would have been here simpler, and more obviously allowable, to suppose at once $B = \frac{Q}{m}A$, then $B_{\prime} = \frac{Q_{\prime}}{m_{\prime}}$ $A_{\prime} = \frac{Q_{\prime}}{m_{\prime}}m_{\prime}A = Q_{\prime}A_{\prime}$, and $Q_{\prime} = Q + n_{\prime}$, whence $\dot{Q} = n_{\prime}$ as

before. The integral, $\frac{1}{2}\ n_{,}n$, is obtained by the well known rule. "Let the increment be reduced to the products of arithmetical progressionals, whose common difference is the quantity by which the variable magnitude is increased at every step, and the integral of each increment will be found by multiplying it by the preceding term in the progression, and dividing it by the number of terms thus increased, and by the common difference." Wood's Algebra, N. 429.]

From the third term we find $C_{,} = m^{\backprime}C + n^{\backprime}B$. I suppose $C = \frac{Q}{R}\ B$, and $C_{,} = \frac{Q_{,}}{R_{,}}\ B_{,}$, that is $\frac{Q_{,}mn_{,,}}{R_{,}n}\ B = \frac{m^{\backprime}Q}{R} B + n^{\backprime}B$, or $\frac{Qmn_{,,}}{nR} + \frac{mn_{,,}}{nR_{,}}\ \dot{Q} = \frac{m^{\backprime}Q}{R} + n^{\backprime}$. We may now make $\frac{mn_{,,}}{nR_{,}} = \frac{m^{\backprime}}{R}$, that is $\frac{mn_{,,}n_{,}}{R_{,}} = \frac{m^{\backprime}n_{,}n}{R}$, in order that $\frac{mn_{,,}}{nR_{,}}\ \dot{Q}$ may be $= n^{\backprime}$. But $\frac{mn_{,,}n_{,}}{R_{,}}$ is a new value of $\frac{m^{\backprime}n_{,}n}{R}$, which is therefore constant, and we may make $R = m^{\backprime}n_{,}n$, [and $R_{,} = mn_{,,}n_{,}$], whence $\dot{Q} = n_{,}nn^{\backprime}$, and $Q = \frac{1}{4}\ n_{,}nn^{\backprime}n^{\backprime\backprime}$. Consequently $C = \frac{n^{\backprime}n^{\backprime\backprime}}{4m^{\backprime}}$ B, and $C_{,} = \frac{m^{\backprime}n_{,,}}{n^{\backprime\backprime}}\ C$.

By the fourth term we have $D_{,} = m^{\backprime\backprime}D + n^{\backprime\backprime\backprime}C$. Hence in the same manner we find $D = \frac{n^{\backprime\backprime\backprime}n^{\backprime\backprime\backprime\backprime}}{6m^{\backprime\backprime}}\ C$, and $D_{,} = \frac{m^{\backprime\backprime}n_{,,}}{n^{\backprime\backprime\backprime\backprime}}\ D$. From these terms the manner of forming all the rest is easily inferred: and if we denote each term with its sign by the letters $A, B, C \ldots$, we shall have $\overset{n}{s} = 1.3.5 \ldots (2n - 1)\ \frac{z^{n+1}}{x^{2n+1}} + \frac{n_{,}n}{2m}\ \frac{xx}{zz}\ A \mp \frac{n^{\backprime}n^{\backprime\backprime}}{4m^{\backprime}}$ $\frac{xx}{zz} B + \ldots = 1.3.5 \ldots (2n - 1)\ \frac{z^{+}}{x^{2n+1}} + \frac{(n+1)n\ xx}{2(2n-1)\ zz}\ A\ +$ $\frac{(n-1)\ (n-2)\ xx}{4(2n-3)\quad zz}\ B + \frac{(n-3)\ (n-4)\ xx}{6(2n-5)\quad zz}\ C + \ldots$

And in a similar manner we find the co-efficients of the other series $\overset{n}{s} = 1.3.5\ldots(2n-1)tt\frac{z^{n-1}}{x^{2n+1}} + \frac{(n-1)(n-2)xx}{2(2n-1)zz}A + \frac{(n-3)(n-4)xx}{4(2n-3)zz}B + \frac{(n-5)(n-6)xx}{6(2n-5)zz}C + \ldots$

Moreover, if m be the distance of any term of the series of successive *fluents*, s, s', s'', from the term s, writing $-m$ instead of n, we shall find the value of s^m by the same series. In this case, we must still take the co-efficient of the first term, such that its greatest factor shall be $2n-1 = -2m-1$. But the co-efficient $1.3.5..(2n-1)$, or $(2n-1)..5.3.1.$ may also be written $\frac{(2n-1)..5.3.1.-1.-3-5...}{-1.-3.-5...}$ or $\frac{(-2m-1)(-2m-3)(-2m-5)...}{-1.-3.-5...}$

Now since n is here supposed to be negative, and m affirmative, the whole of the factors $(-2m-1)$, $(-2m-3)$, $(-2m-5)\ldots$ in the numerator are taken away by the same factors in the denominator, and there remain only $\frac{1}{-1.-3.-5..(-2m+1)}$; so that

$$\overset{m}{s} = \frac{z^{-m+1}}{-1.-3.-5..(-2m+1)x^{-2m+1}} + \frac{(-m+1).-m\,xx}{2(-2m-1)zz}A + \frac{(-m-1)(-m-2)xx}{4(-2m-3)zz}B\ldots \text{ or } s^m = \frac{x^{2m-1}}{-1.-3.-5..-(2m-1)z^{m-1}}$$

$$+ \frac{(-m+1)m\,xx}{2(2m+1)zz}A + \frac{(-m-1)(m+2)xx}{4(2m+3)zz}B + \frac{(-m-3)(m+4)xx}{6(2m+5)zz}C + \ldots$$

that is, according to the former series: and this series is the more convenient for finding the fluents $s', s'', s'''\ldots$; the other for the fluxions $\dot{s}$, $\ddot{s}, \ldots$

For completing the expressions, since $\dot{r} = y\dot{z}$, and $\dot{y} = \frac{y\dot{z}}{c}$, we find the fluents $r = cy$, r' $[= (cy\dot{z})' = (c\dot{r})'] = c^2y$, $r'' = c^3y\ldots.$ and taking the fluxions, $\dot{r} = [y\dot{z} =]\ y$, $\ddot{r} = \frac{y}{c}$, $\dddot{r} = \frac{y}{cc}, \ldots$

Then, observing all the signs, from these values of s, $\dot{s}$, $\ddot{s}$, ..., s', s'', s'''..., r, r', r''... and $\dot{r}$, $\ddot{r}$, $\dddot{r}$, ... we find for the angle FHG, $\left(= \frac{1}{2c + 2cd} (rs - r'\dot{s} + r''\ddot{s} - ..)\right.$ the value $\frac{1}{2c+2cd}\left(cy\frac{z}{x}\right.$ $- c^2y\frac{tt}{x^3} + c^3y\frac{3ttz}{x^5} - c^4y\left[\frac{1.3.5ttzz}{x^7} + \frac{xx}{5zz}A\right]...\Big)$: and for the angle FGH, $\left(= \frac{1}{2c + 2cd}\left[- \dot{r}s' + \ddot{r}s'' - .. - P\right)\right.$ the value $\frac{1}{2c+2cd}\left(yx + \frac{y}{c}\left[\frac{x^3}{1.3z} + \frac{-1}{5}\frac{x^2}{z^2}A + \frac{-3}{7}\frac{x^2}{z^2}\right.\right.$ $B + ...] + \frac{y}{u}\left[\frac{x^5}{1.3.5z^2} + \frac{-3}{7}\frac{x^2}{z^2}A + \frac{-5}{9}\frac{x^2}{z^2}B + ...\right]$ $- P\Big)$: the correction P being the value of the same series for the point A.

Another series may also be found for the angle FGH, by correcting the fluents r, r', r'', so that they may all vanish in the point A, when $z = a$. For this purpose we may make $z = a - v$, whence $\dot{z} = -\dot{v}$, and the fluxion of the angle FHG is $\frac{\dot{v}yz}{x}$. $\frac{1}{2c + 2cd}$. Putting therefore, as before, $s = \frac{z}{x}$, we have $\dot{r} = \dot{v}y$, $\dot{w}$ being $= -\dot{v}$, and $\dot{y} = -\frac{-\dot{v}y}{c}$; whence $\dot{r} = -c\dot{y}$, and $r =$ $cd - cy$, d being the value of y at A; consequently $\dot{r}w = -cd\dot{v} + cy\dot{v} = -cdv - c^2y$, and $r' = c^2d - cdv - c^2y$; hence $r'' = c^3d - c^2dv + \frac{1}{2}cdv^2 - c^3y$, $r''' = c^4d - c^3dv + \frac{1}{2}c^2dv^2 - \frac{1}{2.3}cdv^3 - c^4y$, and so forth. Hence the angle FGH is equal to $\frac{1}{2c + 2cd}\left([cd - cy]\frac{z}{x} - [c^2d\right.$ $+ cdv + c^2y]\frac{tt}{x^2} + [c^3d - c^2dv + \frac{1}{2}cdv^2 - c^3y]\frac{3ttz}{x^5} - [c^4d$

$+ c^3dv - \frac{1}{2} c^2dv^2 + \frac{1}{2.3} cdv^3 + c^4y]. \left(\frac{1.3.5ttzz}{x^7} + \frac{1}{5}\right.$ $\left.\frac{xx}{zz} A)...\right).$ And the sum of the angles FAG, FGH, that is GFH $=$

$$\frac{1}{2c + 2cd} \left(cd \frac{z}{x} - (c^2d + cdv) \frac{tt}{x^2} + (c^3d - c^2dv + \frac{1}{2} cdv^2)\right.$$

$$\left.\frac{3ttz}{x^5} - \left(c^4d + c^2dv - \frac{c^2dv^2}{2} + \frac{cdv^3}{2.6}\right) \left[\frac{1.3.5ttzz}{x^7} + \frac{1}{5} \frac{x^2}{z^2} A\right].\right.$$

Where the angle SAD, or the zenith distance, is small, the angle GFH may be conveniently found by this series; but when it becomes greater, we must find the angle FGH by the former series.

Another series may also be obtained for the angle FGH, by the seventh proposition, [containing the author's well known theorem]. If Q be the fluent of $\frac{-z\dot{z}y}{x}$ or of $\dot{x}y$; it follows from that proposition, that while x becomes $x \pm v$, Q will become $Q \pm \frac{\dot{Q}}{\dot{x}} v + \frac{\ddot{Q}}{2\dot{x}^2} v^2 \pm \frac{\dddot{Q}}{2.3\dot{x}^3}$ $v^3 + \ldots$; that is, supposing x to flow uniformly. If, therefore, we take for x its value in any point I, and $x - v$ be its value in A, and $x + v$ in α, the value of the fluent in the point A will be $Q + \frac{\dot{Q}}{\dot{x}} v + \ldots$ and in the point α it will be $Q - \frac{\dot{Q}}{\dot{x}} v + \ldots$ which being deducted from the former, the remainder will be the part corresponding to the line $A\alpha$; and if $SB = \frac{SAq}{S\alpha}$, the angle FGH will be $\frac{1}{c + cd} \left(\frac{\dot{Q}}{\dot{x}} v + * + \frac{\dddot{Q}}{2.3\dot{x}^3} + * + \ldots\right)$. In this case, if we call $\dot{x} = 1$, we have $\dot{z} = \frac{x}{z}$, and $\dot{y} = \frac{-xy}{cz}$: and $\dot{Q}$ being $= y$, $\dddot{Q} = \frac{y}{czz} \left(\frac{x^2}{c} - \frac{tt}{z}\right)$, $\overset{5.}{Q} = \frac{y}{c^2z^4} \left(\frac{x^4}{cc} - \frac{6ttx^2}{cz}\right.$ $\left. + \frac{3tt}{z} (z - c) \frac{1 + 5x^2}{z^2}\right) \ldots$

Scholium. The radius of curvation of this curve is $\frac{(2+2y)c \times SB\ \text{cub.}}{y \times SQ \times SAq}$, which in the point A is $\frac{(2 + 2d)c \times SA,}{d + SD}$;

and when SAD is a right angle, $\frac{2+2d}{d}c$: and this, according to the values of c and d already assigned [that is $c = \frac{1}{760}$ and $d =$ .00052828, according to Hawksbee], becomes about 5SA; and the curvature is $\frac{1}{5}$ of the curvature of a great circle of the earth, [consequently the depression from refraction $\frac{1}{10}$.] But the velocity of light being to that of a body revolving in a great circle by the force of gravity nearly as 40,000 to 1, the refractive force of the "air" [atmosphere] is to that of gravity about as 320 000 000 to 1: the forces being as the curvatures and as the squares of the velocities.

[*Remarks.* If we now attempted to compute the horizontal refraction by these methods, we should have to substitute SA $= a = 1 =$ SD $= b =$ SE $= t$, z, at A $= 1$, at B or C, $= 0$: then $x = \surd(tt - zz) = 0$ at A, and at B $= 1$, and y the density decreasing from d at A to 0 at B. Here it is obvious, that the series for FHG cannot be directly applied, each of its terms containing x and y: and for a similar reason, the first series for FGH fails: the series for GFH is intended by the author for small zenith distances only: and the last series being multiplied by $\frac{y}{zz}$ is also incapable of direct application without some further explanation.

The remark respecting the series for GFH appears however to be somewhat hasty, since it is the only one which does not altogether fail for the horizontal refraction: its singularity is, that it ought to afford the same result, whatever values of z and x may be employed; the two parts of which it is composed, beginning at the opposite ends of the curve and meeting at the given point: it appears in no case to converge very rapidly, but with proper management it might, no doubt, be employed with success, unless it were thought better to obtain the result by means of differences from the series of refractions in the lower altitudes, which is by no means impracticable. Perhaps, indeed, the fourth series, though somewhat awkward, would in fact afford the most compendious mode of computation, taking z the reciprocal of the height of the middle of the effective part of the atmosphere, and computing for a

series of angles expressing the inclinations of the ray to the vertical line at that point.

Account of SIR ISAAC NEWTON'S *Table.*

Dr. Halley, in the *Philosophical Transactions* for 1721, has published a Table of Refractions, which he says was " the first accurate table" made by the " worthy President of the Society:" " the curve which a beam of light describes, as it approaches the earth, being one of the most perplexed and intricate that can well be proposed, as Dr. *Brook Taylor* in the last Proposition of his *Methodus Incrementorum*, has made it evident. The aforementioned Table, I here subjoin for the use of the curious, such as I *long since* received it from its great author; it having never yet, that I know of, been made public." The refraction at the horizon is made 33′ 45″; at 45°, 54″ only, agreeing certainly in the latter case with Hawkesbee's experiments mentioned by Taylor. From the way in which Taylor's investigations are mentioned by Halley, it might naturally be supposed that Newton's computations were independent of Taylor's formulæ; and hence it was natural enough, that Professor Kramp should spare himself the labour of consulting Taylor's book, which has by no means been generally known, though there is no doubt that the table might be computed from some of Taylor's different series: and even if the horizontal refraction were wanting, it might be obtained from the five neighbouring results, by making the fourth difference constant. After this explanation, it will still be interesting to observe the view which Kramp has taken of the history of the problem; for though it will scarcely be practicable to claim for Taylor the whole of the merit which Kramp attributes *upon suspicion* to Newton, yet certainly much maybe learned from Taylor's method of conducting the process.

Observations on Newton's Table, by KRAMP. Analyse des Réfractions Astronomiques et Terrestres. 4. Strasb. 1798.

" I. 59. Let us take, for a last example, the table of refractions left us by the greatest of all mathematicians, and the ablest of all observers that have ever existed; the man, without whose disco-

veries our astronomy would scarcely deserve the name of a science, since it is to him alone that we are indebted for our knowledge of the eternal laws of nature, and for the application of computation to these laws; in a word, by the immortal NEWTON. Some years before his death, he communicated to his friend *Halley* the Table of Refraction, which the latter *eagerly* published [*s'empressa*] in the *Philosophical Transactions* for 1721. We are not informed *how* this table was constructed, nor if it is the result of analysis or of observation; if the former, it would be interesting to have the mode of computation employed by Newton. He would have done better undoubtedly if he had explained it: but he was at that time in his eightieth year: let us respect his old age, and let us accept the table such as it is, with the gratitude due to its author.

"60. The Table of Newton gives 33′ 45″ at the horizon, and 54″ at 45°: hence the index of refraction is .0002618 [Hawkesbee's .00026414]. .corresponding to a temperature of 74° of Fahrenheit. And on the other hand, as the temperature of 74°, the horizontal refraction of Newton is exactly what it ought to be, supposing the temperature of the atmosphere uniform throughout. Now if this agreement depended on direct observation, it would perhaps be a case unparalleled in the whole history of the physical sciences, especially as we shall see hereafter, that all the refractions in the neighbourhood of the horizon, agree almost as exactly with the conditions of the analysis, which they are very far from doing in the three tables of Bouguer. If the table was calculated, we may first ask," says Kramp, "for what reason Newton fixed on the temperature of 74° rather than any other;" but in fact he fixed on no temperature: "and secondly, how he arrived at the formula, which alone is capable of making the refraction exactly 33′ 45″ at this temperature; and this difficulty is not easily removed: for in fact, that formula depends on a very refined investigation, which was unknown to Euler in 1754, and of which the principles were not well explained before the publication of the Essay of Laplace, "On the Approximation of Formulæ containing Factors raised to High Powers," in the Memoirs of the Academy of Paris for 1782. Are we to suppose that the great Newton obtained the same conclusions

at the beginning of the century, by modes of reasoning which he has left unexplained? This is not, indeed, absolutely impossible for a mathematician to whom nothing was impossible in the higher analysis; but it would be singular that he should have left no trace of the discovery in any other of his immortal writings." So elegant and so important a demonstration could certainly not have been left unrecorded by Newton, if it had occurred to him: but he does not appear to have entered, in the latest period of his life, into any very deep speculations relating to pure mathematics; nor to have been employed on any physical problem which was likely to lead him to the investigation, having in all probability found it sufficient for the present purpose to follow the steps of Taylor's ingenious researches.

Theory of SIMPSON *and Table of Bradley.*

The greatest practical improvement on Newton's Table was made before the year 1743 by Thomas Simpson, who computed the effects of the atmosphere on a ray of light, upon the supposition of a uniform decrease of the air's refractive force in ascending, and obtained from observations communicated to him by Dr. Bevis, a table which gives 33′ 0″ for the horizontal refraction, and 53″ for the altitude 45°. He computes his refractions by taking $\frac{2}{11}$ of the difference of two arcs of which the sines are as 1 to .9986: and he observes, that the distribution of heat in the atmosphere is the reason why the computation upon the supposition of an equable temperature is so erroneous: though he exaggerated the error of this hypothesis so much, as to make the horizontal refraction 52′: being probably unacquainted with the computations of Taylor and Newton, which had been published twenty or thirty years before.

The Table of *Bradley*, which has been so universally admired and employed by the English astronomers and navigators, was obtained from that of Simpson, by the very slight modification of adopting $\frac{1}{6}$ instead of $\frac{2}{11}$ for the multiplier of the difference of the arcs, the correction having of course been obtained from observation only; but with the fondness for approximative computation

which has often been remarked in practical astronomers, Dr. Bradley chose to begin by supposing the approximate refraction known, and to correct it so as to make it exactly proportional to the tangent of the zenith distance diminished by three times the refraction. Leaving the horizontal refraction 33′ 0″, as assigned in Simpson's Table, he makes it 57″ at 45°, instead of 53″. Dr. Bradley has, however, the merit of having first introduced an accurate mode of allowing for the effect of the actual temperature of the atmosphere at the place of observation, which he estimates at $\frac{1}{400}$ of the whole refraction for each degree of Fahrenheit above or below the standard temperature of 50°.

Account of EULER'S *Investigations, fom Kramp*, Chap. v.

The Memoir of Euler, contained in the Transactions of the Academy of Berlin for 1759, though of no importance whatever to optics or to astronomy, may however become still more useful, if properly considered, in a moral point of view, than if had been completely successful. It may not only teach us a proper diffidence in our own computations, but it may serve to show, among many other instances, how liable the greatest and wisest of mankind are to imperfections and errors, even in those departments which they have cultivated at other times with the greatest success. An extract from the account given by Kramp of Euler's results, will render it sufficiently obvious, how much valuable time and useless labour might have been spared if Euler had only happened to look at a few pages of Taylor's little work, which was printed nearly fifty years before.

The formula adapted by Euler for expressing the elasticity E at the height x is $E = \frac{f}{f+x}$, f being the subtangent or modulus, which differs very little from the logarithmic progression of densities when the temperature is supposed constant, that is $E = e^{-x:g}$. From this expression he deduces the fluxion of the angle described by the ray; but in attempting to assign its fluent, the art of this profound mathematician has completely failed him; and he has

thought it justifiable to have recourse to the very arbitrary and incorrect supposition that the curve may be considered as nearly agreeing with a hyperbola, having for its equation $t = Cy^{m-1}$. The refraction is indeed easily computed upon this hypothesis; but it becomes, as Kramp has shown, at the horizon, 42′, instead of 36′ 26″, as it ought to be in the supposed state of the atmosphere, and at 45°, no less than $2\frac{1}{2}'$ instead of about 57″. In short, the failure could not possibly have been more total, if the essay had been the work of the idlest schoolboy, instead of one of the four or five greatest mathematicians that have ever existed: for in the same rank with Archimedes and Newton, and Euler and Laplace, it is difficult to say what fifth philosopher has any right to be classed: perhaps Leibnitz, and possibly Lagrange; but this question will long remain undecided, if it requires to be determined by a jury of their peers.

Methods of MAYER *and* LAMBERT. Kramp, v. 41, 47.

The formula of Mayer was published without demonstration in his Lunar Tables, and appears to have been only an empirical modification of those of Euler and Bradley, approaching so nearly to Bradley's results as scarcely to require any distinct consideration.

Lambert published in 1759, at the Hague, a separate essay, entitled *Les proprieties remarquables de la route de la Lumière par les airs;* and he resumed the subject in the Berlin Almanac for 1779. He has adopted in this research a supposition respecting the asymptote of the curve which Mr. Kramp has shewn to be inadmissible; and his method of computation exhibits an error at the horizon amounting to 87″. But " Lambert might have concluded" says Kramp, " from his own geometrical investigations, the approximate result which Mayer had already obtained in part, that is, that for the same absolute elasticity" as expressed by the height of the barometer, " the horizontal refraction must be reciprocally proportional to the square root of the cube of the specific elasticity," depending on the temperature; and he contradicted himself when he objected to what Mayer had said on this subject."

Epoch of KRAMP *and* LAPLACE.

For the mathematical theory of refraction it may be said that nothing of immediate importance was done from the time of Newton and Taylor, to that of Laplace and Kramp. It is true, that the XVIth volume of the New Commentaries of Petersburg, for the year 1771, contains an Essay of Euler, in which the particular value of a fluent is first demonstrated, which is of singular importance in abridging the computation of the horizontal refraction; but it does not seem to have occurred to this great mathematician in what manner his discovery might be rendered serviceable for the solution of a physical problem. It was in the Memoirs of the Academy for 1782, that *Laplace* made public an essay on the integration of differential functions, which contain very high powers of their factors; and this essay Kramp considers as first developing the principle that led to the more accurate solution of the problem.

Professor Kramp had made himself known and respected in the mathematical world, by his attempts to apply the principles of mechanical hydraulics to the circulation of the blood in health and in disease, and he was the author of some interesting essays on the combinatorial analysis of Hindenburg, which excited at one period so much attention in Germany, though none of its other results appear to have been so satisfactory, as those which are contained in the chapter on Numerical Faculties of the Analyse des Refractions. The rapid and brilliant progress that is displayed in this chapter through some of the most thorny paths of analysis will for ever distinguish its author among the original contributors to the advancement of mathematical analysis; but it is, perhaps, somewhat too rapid to have avoided all traces of contact with the thorns that were to be encountered. The originality consists principally in the very great generalisation of the laws of the faculties of numbers, which have been since more commonly called factorials, and in their extension to faculties with fractional indices, formed according to the analogy of fractional powers, but which, in fact, though they may be shown to have real values, are little less imaginary in their immediate structure, than the square roots of negative numbers, and resemble still more

nearly the fluxions of fractional orders. Having first deduced from the series which expresses the relation of the sides of any two polygons, the general value of the product of two faculties (§.16): he transforms the faculty $1^{m:n|1}$, divided by m, into another which he shows to agree in its general term with the series expressing the fluent ${}^{0}\int_{\infty} t^{m-1} e^{t^n} \mathrm{d}t$, as it is obtained from the series of Taylor, or of Bernoulli, for integration by parts. He derives also, from a similar method of investigation, some very compendious expressions for computing the same fluent for any other values of t, and gives, at the end of his volume, some tables of their results, which have lately been much extended by Bessel in his Fundamenta. For the horizontal refraction, which is expressed by $\sqrt{(\frac{1}{2}\, n\omega\pi)}\ (1 + An + Bn^2 + \ldots)$ he finds $A = .414214$, $B = .262649$, $C = .200865$, $D = .160253$, and $E = .132935$; (see *Coll.* No. XV.): and from the values assigned by Laplace in his Exposition, he computes the refraction equal to 7307 decimal seconds at the freezing temperature, differing but little from the 7300 assigned to it by Laplace. Concluding, from observation, that a uniform temperature of the atmosphere will not properly represent the actual refractions, he suggests the alteration of the quantity denoting the subtangent, or modulus of elasticity, in such a manner as to correspond with the actual state of the phenomena; and this is precisely what has since been attempted by Professor Bessel. He also observes, that the refractions near the horizon by no means follow the exact proportion of the densities, and gives a table extending from 10° to 100° of Fahrenheit, which shows that within these limit, the refraction varies in the ratio of 27 to 37, while the densities are supposed to vary only in the proportion of 21 to 25 or 52 to 62.

In the precise determination of the refractions very near the horizon, Professor Kramp has not been particularly fortunate. The terrestrial refraction, which is the subject of his fifth chapter, presents no particularly difficulty; and neither of these investigations, as belonging to the hypothesis of an equable temperature, presents any remarkable interest at present. The method of Laplace, which is well known from the Mécanique Céleste, has deservedly su-

perseded that of Kramp, especially from the extreme elegance and conciseness with which the definité fluent already mentioned is there obtained by means of the method of partial fluxions; and the hypothesis respecting the distribution of temperature, which has been practically adopted by this illustrious philosopher, has led to the construction of tables possessed of accuracy abundantly sufficient for every purpose of astronomy, and which ought never to have been set aside by the German astronomers, in order to return to the mere speculative suggestion of Kramp, however elaborately computed and partially supported by their ingenious countryman, Professor Bessel. At this period of the history of refraction, the investigation had attained all the practical perfection that could be desired: it will be proper to proceed in the second place to the consideration of the later attempts that have been made to improve it by the mathematicians and astronomers of the British empire.

Part II. *Account of the later improvements in the theory of* Atmospherical Refraction.

From the time of the publication of the French tables of refraction, constructed from the computations of the illustrious Laplace, the determination has acquired a degree of accuracy rather exceeding than falling short of what might have been expected from the fluctuating state of the elements on which it depends.

Our countryman Mr. Groombridge is the first astronomer that seems to have undertaken an elaborate series of observations almost entirely for the purpose of obtaining a complete table of refractions. His first publication is contained in the Philosophical Transactions for 1810. The mode of computation that he has employed, to obtain the mean refraction at a given altitude, is to observe the same star above and below the pole; and to take the sum or difference of the apparent altitudes, which, compared with the double latitude, gives the sum or difference of the refractions at the given altitudes: then by comparing these results with those of an approximate table, he finds the mean factor

required for multiplying the numbers of the table; and in this manner he has obtained for Bradley's Table, first reduced on account of the sun's parallax, the factor 1.02845 and has proposed still further to improve it by adopting the form

$$r = 58.1192 \text{ ta } (Z. .D. - 3.3625r).$$

Mr. Groombridge has not recorded the particular temperatures of his observations, but has reduced them to the mean temperature of the table, which is supposed to be 49° for the interior thermometer, and 45° for the exterior. The results may, however, be of use in continuing upwards the Empirical Table, inserted in a former number of these Collections (XIII) from Mr. Groombridge's later observations, and it will be perfectly justifiable to divide the sum of the two refractions in the ratio of the corresponding refractions of any approximate table, in order to determine the larger of the two with little chance of error. In this manner we may obtain the following Table, selecting the observations, at convenient altitudes, which have been most frequently repeated.

Stars.	Obs.	Alt.	Refr.	N. A.		Diff.
		° ′ ″	′ ″	′ ″		″
α Pers.	12	10 42 41.0	4 55.2	4 58.7	+	3.5
ϑ Cast.	7	15 38 37.0	3 23.9	3 25.5	+	1.6
2 Lync.	7	20 34 14.6	2 31.4	2 34.0	+	2.6
ο Ceph.	5	28 33 11.9	1 45.9	1 47.1	+	1.2
5 Urs. Min.	5	38 2 32.3	1 14.7	1 14.3	−	0.4
Camelop. H. 30	9	45 0 46.5	0 57.5	0 58.1	+	0.6
Polaris	41	49 45 31.5	0 48.7	0 49.2	+	0.5

Mr. Groombridge has also taken some pains to ascertain from observation, the magnitude of the thermometrical correction, though without distinguishing the different effects at different altitudes; and he finds for the exterior thermometer .0021 for every degree of variation reckoned from 45°, and .0023 or .0024 for the degrees of the interior thermometer reckoned from 49°. His own formula is thus compared with the French Tables, and with Piazzi's empirical correction. Barometer 29.6.

Alt.	Gr. 1810.	Fr. T.	Piazzi.	Gr. 1814.
° ′	′ ″	′ ″	′ ″	′ ″
0 0	31 27.9	33 46.3	32 3.0	34 28.1
1 0	23 46.8	24 21.2	23 46.1	24 32.9
2 0	18 19.2	18 22.2	18 2.7	18 19.8
2 0	14 31.7	14 28.1	14 25.1	14 19.8
4 0	11 52.2	11 48.3	11 42.6	11 45.3
5 0	9 57.3	9 54.3	9 45.4	9 53.0
10 0	5 19.8	5 19.8	5 16.1	5 19.2
20 0	2 38.4	2 38.8	2 37.8	2 38.3
45 0	0 58.0	0 58.2	0 57.2	0 58.0

We find in the Transactions for 1814, a continuation of Mr. Groombridge's researches extended to the refraction of stars near the horizon. He observed, that the results, corrected according to the indications of the thermometer *without*, are the most correct; he alters the thermometrical factor from .0021 to .002, and adopts finally the expression $r = 58.'' 132967 \times \text{ta}\,(Z.D - 3.6342956r)$, reducing it, below 87°, .00462 for each minute.

Dr. Brinkley, in 1810, had acquiesced in the formula of Simpson and Bradley, with a slight modification, and with the French correction for temperature, that is $r = 56''.9\ \text{ta}\,(Z.\,D - 3\,.\,2r)\,\dfrac{B}{29.6}\cdot\dfrac{500}{450 + F}$. (Ph. tr. P. 204.)

Dr. Brinkley has pursued the subject with his accustomed accuracy in the Irish Transactions for 1815, and has employed 65 observations of Capella and 42 of Lyra, together with a multitude of others, confirming the accuracy of the French Tables. He has shown the agreement of several assumed hypotheses, in moderate zenith distances. Thus, at 50° F. and 29.6 B.

Alt.	Obs.	Fr. T.
°	′ ″	′ ″
16	3 18.6	3 18.2
20	2 37.3	2 37.0
30	1 39.7	1 39.4
40	1 8.7	1 8.6
45	0 57.7	0 57.6

He therefore recommends the employment of the French Tables for moderate zenith distances, and remarks that nearer the horizon it is useless to expect minute accuracy in any conclusion from astronomical observations.

In the XIIth volume of the Irish Transactions, we find a memoir of Dr. Brinkley, read in 1814, (Coll. VI,) on the thermometrical correction of refraction; giving a method of correction " derived from the formula" of Simpson, " obtained in the hypothesis of a density decreasing uniformly." The author observes, that " at present we have not sufficient observations to determine, whether the actual variations of refractions at low altitudes are most conformable to the theory of Mr. Bessel, to that of Dr. Young," or to his own: which, indeed differs less from each other than they do from the corrections employed by the French, by Groombridge, or by Bradley; and after all, it seems impossible to expect much advantage from any theory in applying this correction to the accidental variations of any one climate, though it may very probably be of use for finding the mean refractions in distant latitudes. (See Coll. XIII.)

It was in the interval between the publication of Dr. Brinkley's two papers, that Dr. YOUNG annexed a new Table of Refractions to the Nautical Almanac, founded on an approximation of his own, but agreeing almost exactly in the mean refractions with the French Tables, adopting, however, a correction for temperature derived from theory, and greater near the horizon than that which the French have employed. Having observed that the series obtained for expressing the refraction in terms of the density failed at the horizon, because the altitude was a divisor of the coefficients, it occurred to him that this inconvenience might be avoided, by expressing the density in a series of the powers of the refraction; and the formula thus obtained, though not always convenient in extreme cases, is still very useful for obtaining a tolerably accurate result with great facility from any imaginable theory, and is also capable of representing, by a few of its first terms only, with their coefficients empirically modified, the refraction either actually observed, or correctly computed, upon any possible hypothesis respecting the constitution of the atmosphere.

Dr. Young's theorem is $p = \frac{v}{s} r + \left(\frac{\zeta}{mp} - 1\right) \frac{rr}{2ss} + \mathrm{d} \frac{\zeta}{mpz} \frac{r^3}{6s^3 \mathrm{d}r} + \ldots$ When r vanishes, or near the zenith, the first term of the series only determines it, and it becomes simply proportional to the refractive density p; at a greater distance the second term becomes sensible, depending on the total variation of the actual density in ascending a given height, ζ being $= \frac{dy}{dz}$: this coefficient ought, therefore, to be the same in every hypothesis concerning the constitution of the atmosphere, which professes to represent correctly the initial diminution of temperature of density in ascending; how this diminution may vary at greater heights cannot easily be determined from direct observation, since we cannot reason with certainty on the temperature of the open atmosphere remote from the earth, from that of the surfaces of mountains, which may very possibly be affected by their immediate contact with the solid earth, and it seems necessary to obtain the subsequent coefficients from the phenomena of refraction, as observed in favourable circumstances, taking also the mean of a great number of results.

In the approximatory method of using four terms only, it may become convenient to modify even the first two, in order to cooperate the more perfectly with the succeeding ones; but it is difficult to suppose that the actual constitution of the atmosphere can be represented with *great precision* by a hypothesis like that of Laplace, in which the initial variation of temperature is made greater than the truth. That there is no actual necessity for such a departure from observation, is shown by Mr. Ivory's table, and by Dr. Young's latest solution of the problem, both of which begin with assuming the initial variation of temperature equal to that which is actually observed: while Mr. Ivory supposes the rate of variation to become slower in ascending, and Dr. Young more rapid, and yet the results agree very nearly with each other, and with the French tables, except quite close to the horizon.

The ridiculous accusations which were brought against Dr. Young, and against the British Government, by an unfortunate

enthusiast, whose imprudence seems almost to have impaired his reason, might perhaps serve in some slight degree, if they served for any thing, to make it probable that the method which he so clamorously professed to have improved, was in itself of *some* value: but as even this does not yet appear to be *universally* admitted, it may not be superfluous to give one or two additional instances of its application.

The general equation, as investigated in the sixth number of these Collections, is $ps = vr + \left(\frac{\zeta}{2mps} - \frac{s}{2}\right) r^2 + \left(\frac{\zeta'}{6mps} + \frac{\zeta v}{6mp^2s^2}\right) r^3 + \left(\frac{\zeta''}{24mps} + \frac{\zeta' v}{24mp^2s^2} + \frac{\zeta}{24mp^2s^2}\left(\frac{\zeta}{mps} - s + \frac{\zeta v^2}{12mp^3s^3}\right) r^4 + \ldots$; ζ being $= \frac{dy}{dz}$, $\zeta' = \frac{d\zeta}{dr}$, and $\zeta'' = \frac{d\zeta'}{dr}$; and we may take for $\frac{1}{m}$ .001294, and for p, .0002835, so that $\frac{1}{mp} = 4.5644$, and $\frac{1}{mp^2} = 16100$.

A. The first hypothesis of Kramp has been abandoned by Bessel on account of its intricacy, and it has lately been declared even by Mr. Ivory "*too complicated for calculation.*" We have here $z = e^{-\frac{1}{\varepsilon}(e^{\varepsilon\sigma}-1)+\varepsilon\sigma}$, σ being $= m(x-1)$, and $\mathrm{d}\sigma = m\mathrm{d}x = \frac{-\mathrm{d}y}{z}$, and since $\frac{\mathrm{d}y}{\mathrm{d}r} = \frac{-\zeta v}{ps}$, $\frac{\mathrm{d}\sigma}{\mathrm{d}r} = \frac{\zeta v}{psz}$: but $\mathrm{d}z = z\mathrm{d}\left(\frac{1}{\varepsilon} - \frac{1}{\varepsilon}e^{\varepsilon\sigma} + \varepsilon\sigma\right) = z\varepsilon\mathrm{d}\sigma\,(1 - \frac{1}{\varepsilon}e^{\varepsilon\sigma}) = -z\varepsilon\frac{\mathrm{d}y}{z}\,(1 - \frac{1}{\varepsilon}e^{\varepsilon\sigma}) = -\varepsilon\mathrm{d}y\,(1 - \frac{1}{\varepsilon}e^{\varepsilon\sigma})$, and $\zeta = \frac{-1}{\varepsilon - e^{\varepsilon\sigma}}$, or initially $= \frac{-1}{\varepsilon - 1}$, which must be $= \frac{5}{4}$, and $\varepsilon = \frac{1}{5}$, and in general $\zeta = \frac{5}{5e^{\varepsilon\sigma} - 1}$, whence $d\zeta = \frac{-25\varepsilon e^{\varepsilon\sigma}\mathrm{d}\sigma}{(5e^{\varepsilon\sigma} - 1)^2}$ and $\frac{\mathrm{d}\zeta}{\mathrm{d}r} = \zeta' = \frac{-25\varepsilon e^{\varepsilon\sigma}\zeta v}{(5e^{\varepsilon\sigma}-1)^2 psz}$, and lastly $\frac{\mathrm{d}\zeta'}{\mathrm{d}r} = \zeta'' = \zeta'\left(\frac{\mathrm{d}v}{v\mathrm{d}r} + \frac{\mathrm{d}e^{\varepsilon\sigma}}{e^{\varepsilon\sigma}\mathrm{d}r} + \frac{\mathrm{d}\zeta}{\zeta\mathrm{d}r} - \frac{d(5e^{\varepsilon\sigma}-1)^2}{(5e^{\varepsilon\sigma}-)^2 dr} - \frac{\mathrm{d}z}{z\mathrm{d}r}\right)$: whence initially $\zeta' = \frac{-25}{64}\frac{v}{ps}$,

and $\zeta'' = \frac{-25}{64ps}\left(\frac{\zeta}{mps} - s + \frac{v\varepsilon\zeta v}{ps} + \frac{\zeta' v}{\zeta} - \frac{8d\sigma v}{16dr} + \frac{v^2}{ps}\right)$ $= \frac{-25}{64ps}\left(\frac{\zeta}{mps} - s + \frac{\varepsilon\zeta v^2}{ps} + \frac{\zeta' v}{\zeta} - \frac{\zeta v^2}{2ps} + \frac{v^2}{ps}\right) = \frac{-25}{64ps}$ $\left(\frac{\zeta}{mps} - s + \frac{v^2}{4ps} - \frac{5v^2}{16ps} - \frac{5v^2}{8ps} + \frac{v^2}{ps}\right) = \frac{-25}{64ps}\left(\frac{\zeta}{mps}\right.$ $\left. - s + \frac{5v^2}{16ps}\right)$. By substituting these values, we obtain the equation $ps = vr + \left(\frac{2.85275}{s} - \frac{1}{2}s\right)r^2 + 2306\,\frac{v}{ss}r^3 + \frac{576}{ss}$ $\left(\frac{5.7055}{s} - s + 5450\,\frac{v^2}{s}\right)r^4$.

With this formula, we may proceed to calculate the refraction for the case $v = .1$, that is, for an altitude of 5° 44′ 21″, which will be allowed to be as low as can possibly be required for any accurate observations. Assuming then $r - .0026$, we have $r^2 = .000\,006\,76$, $r^3 = .000\,000\,017\,576$, and $r^4 = .000\,000\,000\,0457$; also $s = .99500$, $s^2 = .9900$, and $s^3 = .9850$, and the equation becomes $p = .00026130 + .00001610 + .00000411 + .00000157 + [.000\,001\,50] = .000\,28458$, so that .0026 is too much by about $\frac{1}{300}$, and $r = .00259$, which may be called certain to the last figure, giving 8′ 54″.2, a result probably very near the truth in the actual mean state of the atmosphere.

B. Mr. Ivory's tables are constructed upon the hypothesis $y = .75z + .25z^2$; hence $\zeta = \frac{dy}{dz} = .75 + 5z$, $\zeta' = \frac{d\zeta}{dr} = \frac{.5dz}{dr}$ $= \frac{-v}{2ps}$, and $\zeta'' = \frac{-1}{2ps}\,\frac{dv}{dr}$; the equation then becomes $p = \frac{vr}{s}$ $+ \left(2.85275 - \frac{1}{2}ss\right)\frac{rr}{ss} + 2012\,v\,\frac{r^3}{s^3} + 503\,(4.7055 + 7055\,v^2)$ $\frac{r^4}{s^4}$, and assuming again $\frac{r}{s} = .0026130$, $\frac{r^2}{s^2} = .000\,006\,8276$, $\frac{r^3}{s^3}$ $= .000\,000\,01784$, and $\frac{r^4}{s^4} = .000\,000\,000\,0467$, we have $p =$

.000 261 30 + .000 016 10 + .00000359 + .000 001 77 + [.000 002 40] = .00028516, too much by about .00000164, and we must subtract $\frac{1}{180}$, and we have $r = .002586 = 8'\ 5''.34$, with an uncertainty that cannot exceed a few seconds: Mr. Ivory's table, which may possibly be correct, but which would naturally be a little within the truth rather than beyond it, since it is computed by a direct converging series, has 8′ 48″.0, which is 5″.4 less. It cannot be supposed that Mr. Ivory's method requires any such confirmation, but it would be easy to add a few more terms to this series as a test, if there were any necessity for the perfect accuracy of the determination by two opposite methods.

C. The approximation lately communicated to the Royal Society, which supposes $y = 1.5z^{1.5} - .5z^2$, gives $\zeta = \frac{dy}{dz} = 2.25\sqrt{z} - z$, whence $\frac{dv}{dr} = \frac{\zeta}{mpsz} - s = \frac{2.25}{mps\sqrt{z}} - \frac{1}{mps}$, $d\frac{dv}{dr} = \frac{-1.125dz}{mpsz\sqrt{z}}$, $\frac{d^2v}{dr^2} = \frac{1.125v}{mp^2s^2z\sqrt{z}}$, the fluxion of this initially $\frac{1.125}{mp^2s^2}$ dv $-$ $\frac{.6875v}{2}$ dz, and $\frac{d^3v}{dr^3} = \frac{1.125}{mp^2s^2}\frac{dv}{dr} + \frac{1.6875}{mp^2s^2}\cdot\frac{v^2}{ps}$: consequently $p = \frac{v}{s}r + (2.85275 - \frac{1}{2}ss)\frac{rr}{ss} + 3019\,v\frac{r^3}{s^3} + 755\,(4.7055 + 5291v^2)\frac{r^4}{s^4}$: and, for $r = .0026$, $p = .0026130$ + .000 016 10 + .000 005 39 + .000 002 03 + [.000 002 00.] = .000 286 82, requiring for r a reduction of $\frac{1}{100}$, whence $r = 0025740 = 8'\ 50''.9$, with an uncertainty not exceeding 2″ at the utmost. And the direct computation by logarithms gives 8′ 49″.6, differing only 1″.3 from the series in this almost extreme case: the series being in this hypothesis a little more rapidly convergent than in some others, so that it would be unnecessary to compute more terms if it were to be employed for any practical purpose. It may be remarked that the omission of v^2 in the fourth term is not quite so unimportant to the result as it appeared at first sight, though it is

compensated, in the approximation that has been adopted, by the alteration of the other coefficients.

Mr. Ivory, observing with some truth that Dr. Young's inverse series was not in all cases so convergent as could be desired, or even as the author appeared to believe it, has still more lately applied the powerful machinery of his analytical investigations to the construction of some tables upon a hypothesis which seems in most respects to represent the constitution of the atmosphere with sufficient accuracy, and which agrees also extremely well with the most approved observations. Mr. Ivory adopts the opinion of Schmidt, and of some later experimental philosophers, that a diminution of temperature diminishes the actual bulk of a given portion of air by an equal quantity of space for each degree of the thermometer, and infers that, at the temperature of about $-500°$ of Fahrenheit, the air would cease to occupy any space whatever as such, or in the form of a gas. He seems, however, to have imagined in some of his earlier papers, that the diminution of temperature might still be equable in ascending to all possible heights; and even in his essay, printed in the Transactions for 1823, he says, "there is no ground in experience for attributing to the gradation of heat in the atmosphere any other law than that of an equable decrease as the altitude increases ...: it therefore seems to be the assumption most likely to guide us aright in approximating to the true constitution of the atmosphere." From this hypothesis he derives the very convenient conclusion that the pressure must vary at a certain power of the density, or that $y = z^n$, n being nearly $\frac{5}{4}$: but finding it impossible to suppose the atmosphere so little elevated as this hypothesis would require, he modifies it by the addition of another term to the value of y, though without very clearly relinquishing in words the original supposition, and ultimately adopts an expression equivalent to that which has already been mentioned in this paper, or $y = .75z + .25z^2$.

Mr. Ivory first expands the well known expression for the refraction into a series by means of the binomial theorem, and finds

the value of the particular fluents of the several terms from considerations nearly resembling those which Laplace has employed in the Celestial Mechanics, so that the fluent of $e^{-tt}\,dt$ becomes a particular case of his solution. Then taking $y = z^{\frac{5}{4}}$, he computes the horizontal refraction 34′ 1″.3, instead of 33′ 51″.5, which is the result commonly adopted, and he finds at all altitudes the formula differs a few seconds only from the French tables. But this equation supposes the whole height of the atmosphere to be no more than about 25 miles, since $dy = \frac{5}{4} z^{\frac{1}{4}}\,dz$, and $dx = \frac{-dy}{mz}$ $= \frac{-5}{4m} z^{-\frac{3}{4}}\,dz$ and $\int dx = \frac{-5}{m} z^{\frac{1}{4}} + \frac{5}{m}$, and $\frac{1}{m}$ is a little more than 5 miles. Mr. Ivory therefore inquires, what would be the effect of an atmosphere in which $y = fz^2 + (1-f)z^{1+\frac{1}{n}}$, f being $= \frac{n-4}{4n-4}$; so that when $\frac{1}{n} = 0$, and $n = \infty$, $f = \frac{1}{4}$, and $y = \frac{1}{4}z^2 + \frac{3}{4}z$, the height being thus made to vary from 25 miles to infinity. But in all these cases he observes, that the rate at which the heat decreases, becomes slower at greater heights than at smaller.

"When n is less than 4, f becomes negative; but these cases are excluded, since they belong to atmospheres still less elevated than when $n = 4$. They are excluded too for another reason: for although the rate of the decrease of heat at the earth's surface agrees with nature, yet it increases in ascending, which is contrary to experience." Among these excluded atmospheres is that which supposes $y = \frac{3}{2} z^{\frac{3}{2}} - \frac{1}{2} z^2$: and no doubt the first objection against its pneumatical accuracy is valid; and Mr. Ivory's expression is more accurate at extreme heights; but there is no ground whatever from experience to deny that the rate of decrement of temperature initially increases: the observations of Humboldt, Leslie, and others, on mountains, have sufficiently shown that the rate increases for the earth's surface, and it will be therefore difficult to show that it must be otherwise for the atmosphere;

it is indeed possible that, though the atmosphere is certainly of the same mean temperature as the earth at the base of the mountain, and probably at its summit, it may be a little colder at the middle of its height; but this diversity is by no means shown by any actual observations that have been recorded; and even if Mr. Ivory's hypothesis for the densities be allowed to be most probable, it will not follow that the temperatures must not decrease more rapidly at moderate heights than he supposes, in order that the contraction of bulk may keep pace with his formula.

For the atmosphere of infinite height, in which $f = \frac{1}{4}$, Mr. Ivory finds the horizontal refraction 34′ 18″.5, or 17″.2 more than for an atmosphere 25 miles in height, and 27″ more than the quantity generally admitted by astronomers. It seems, therefore, to follow that for an optical hypothesis, an atmosphere *less* than 25 miles high might have the advantage; even if it did not afford the greater facility of direct computation which has since been pointed out.

Having examined the comparative effect of different hypotheses respecting the height of the atmosphere on the refraction, Mr. Ivory proceeds to accommodate his formulas to the more ready computation of the mean refraction, and of the barometrical and thermometrical corrections in the case of the constitution, which appears on the whole to come the nearest to the truth. It seems, however, questionable, whether the value of the exponent of the density $\frac{5}{4}$ is not a little too great, since it is derived from observations on mountains at small heights; for it is probable that the very summits of the highest mountains that we can ascend ought to be chosen for determining the rate of variation of temperature, if it is to be supposed uniform, and that if we take the exponent $\frac{dz}{dy} = \frac{5}{4}$ only, there will be a deficiency which requires to be compensated, by assuming the rate of variation to become more rapid in ascending; and this seems to be the case in the atmosphere of 18 miles,

which agrees so nearly with the results of Laplace's hypothesis, in which $\frac{dz}{dy} = 1.396$ (Coll. XIV.)

There is a mathematical paradox in the latter part of Mr. Ivory's paper, which requires some further explanation.

"The density in the hypothesis of Kramp" being too complicated for calculation, he deduces from it, says Mr. Ivory, "this more simple value," $z = e^{-(1-\epsilon)\sigma}$ "by retaining only the part of the expansion of the function in the index that contains the first power of σ."

"In all this Kramp is followed by Bessel, whose aim it is to determine the value of ϵ that will best represent all the observations of Dr. Bradley, without paying any regard to the terrestrial phenomena, or to any further theoretical considerations whatever.

"Now, there is an essential distinction between the rigorous expression of the density, and the approximate value used instead of it. The latter belongs to a finite atmosphere, and the former to one of unlimited extent; . . . and the total height will be determined by the equation" $e^{-(1-\epsilon)\sigma} - \epsilon = 0$.

"At the surface of the earth, we ought to have $\epsilon = \frac{1}{5}$; which would limit the atmosphere to about double the height in the hypothesis of Cassini. Bessel determines $\epsilon = \frac{1}{28}$ nearly; which is quite inconsistent with the value of" ζ "at the surface of the earth, and with the elevation necessary for depressing the thermometer one degree, as found by experiment. Accordingly, although the refractions in this table represent Dr. Bradley's observations with great exactness as far as 86° from the zenith; yet, at lower altitudes, they diverge greatly from the truth."

Now it seems obvious, that since $z = e^{-(1-\epsilon)\sigma}$, when $e^{-(1-\epsilon)\sigma} - \epsilon = 0$, $z - \epsilon = 0$, and $z = \epsilon$, instead of $z = 0$. However this may be, Professer Bessel certainly states the result very differently from Mr. Ivory, for he says, (*Fund. Astr.* p. 57,)

"Finem huic capiti imponat *stricta* densitatis aeris comparatio,

qualis prodit e formula" I, the correct hypothesis, and II, the approximation.

σ, The height.	z, The density (I)	z (II).
625 toises	.8668	.8671
10000	.0921	.1021
20000	.0068	.0104
40000	.0000	.0001."

Now if the atmosphere terminated when $z - \varepsilon = 0$ and $z = \frac{1}{28}$, the heights placed opposite to the two last numbers of the table must be merely imaginary. The mistake *appears* to be in the correction of the fluent for y the pressure, which seems without necessity to be supposed initially $= 1$.

Mr. Ivory concludes with approving from theory the employment of the interior thermometer instead of the exterior, a method which Dr. Brinkley thinks himself justified in adopting from observation, but which appears, to some of the best judges in Europe, to be one of the causes that have introduced a variety of mistaken opinions among the most refined discoveries of modern astronomy. The evidence of our senses, when continually repeated, is strong enough to convince us of things the most repugnant to our judgment; but it is not so easy to imagine how, from mere theoretical grounds, it can be believed, that a refraction which has taken place at a horizontal surface in the atmosphere above the observatory can be at all annihilated or compensated by a subsequent refraction at a vertical or greatly inclined surface, which separates the air of different temperatures within and without the observatory: for the laws of equilibrium would never allow the separation to remain in a horizontal direction, or near it, even in the most tempestuous weather.

Mr. Ivory's Table of Refractions would certainly deserve to be annexed to this abstract, if it had not already been examined in these Collections, and if the correction for temperature, which is so carefully applied, were more supported by observations, compared solely for that purpose. With respect indeed to this correction, it is highly advisable, that every observatory should have it determined from its own observations only: the mean refrac-

tions of the French Tables are sufficiently established; though, as Mr. Ivory has discovered, they were actually computed for the freezing temperature, and not very perfectly reduced to the mean temperature to which they are assigned; but they are much better than the labour of many years could procure from the observations of a single astronomer only. It may, however, still be advisable to retain the theoretical correction for temperature in the Nautical Almanac, because a work of that kind, which is likely to be consulted in a variety of climates, is required to represent the probable results of the mean constitution of an atmosphere in equilibrium at different temperatures depending on climate, and not the temporary effects of the seasons only, or of the weather at the moment, or of the alternations of day and night.

The grounds of Dr. Young's latest method of computing the refraction will be obvious, from comparing this paper with the demonstrations contained in the XIVth number of the Astronomical Collections, in which the equations $y = z^2$ and $y = z^{\frac{3}{2}}$ are both shown to afford finite expressions for the refraction; and it appears that their combination, in the form $y = \frac{3}{2} z^{\frac{3}{2}} - \frac{1}{2} z^2$ belongs to an atmosphere which might be expected, from Mr. Ivory's investigation, to represent the refraction with extreme accuracy, though it is probably more dense than the true atmosphere at great heights, and yet terminates too abruptly. But the unexpected advantage of combining a perfect representation of the true decrement of heat at the earth's surface, with a very accurate expression of the refraction, in an equation of a finite form, and not laborious in its application, must, at least give this hypothesis some claim to the attention of those who feel any remaining objection to the approximatien that has been employed in the Nautical Almanac.

Professor Schumacher is desirous of having it explicitly understood, that the omission of the passage relating to the preference of the exterior thermometer, in his edition of the English explanation of Dr. Young's Table, was completely accidental; it is retained in the German translation, and Professor Schumacher fully coincides in the opinion that it expresses.

Art. XVI.—MISCELLANEOUS INTELLIGENCE.

I. Mechanical Science.

1. *Influence of Temperature on Stone Bridges.*—M. Vicat has had occasion to observe a striking instance of the effect of change of temperature on a bridge constructed over the Dordogne at Souillac. The bridge was of stone, had seven arches, each of above twenty-four feet span. It was expected that, as the masonry settled, the parapet stones would separate slightly from each other; and, in fact, this took place, but it occurred suddenly and precisely during the very cold weather of February, 1824. Continuing the observation of what took place at the separation thus formed, it was found that cement, with which portions of the cracks had been filled, remained undisturbed during the cold weather; but that as the warm weather came on, it was pressed out, and the joints were closed: and it was ultimately ascertained, that much of the expansion and contraction of the bridge was entirely thermometrical, depending upon the changes of temperature communicated to it from the atmosphere.

One of the most important and evident consequences of this action is, that large arches exposed to the variations of natural temperature are never in equilibrium; and M. Vicat remarks, that these effects are equally produced, and have been observed in arches constructed more than a year previous, and in those which have not been built more than two months; so that the thermometrical expansion and contraction of the stones does not appear to change by time.—*Ann. de Chim.* xxvii. 70.

2. *Vibration of Wires in the Air.*—A gentleman of Burkil, near Basle, in Switzerland, is said to have observed, some years since, that a long iron wire stretched in the air gave musical tones in certain states of the weather. In consequence of this, and other observations, a kind of musical barometer is described as having been constructed by Captain Hans, of Basle, in 1787. Thirteen pieces of iron wire, each 320 feet long, were extended from his summer-house to the outer court, crossing a garden; they were placed about two inches apart; the largest were two lines in diameter, the smallest only one, and the others about one and a half. They were on the side of the house, and made an angle of twenty or thirty degrees with the horizon. They were stretched and preserved tight by wheels for the purpose. During certain changes of the weather, these wires make a considerable noise, resembling that of a simmering tea-urn, an harmonicon, a distant bell, or an organ. It seems to be supposed, that wires placed east and west yield no sound, and that to produce the effect they must be in the direction of the meridian. In the opinion of M. Dobereiner, as stated in the

Bulletin Technologique, this is an electro-magnetical phenomenon.—*N. M. Mag.* xii. 446.

3. *Lapidary's Wheel used in the East Indies for Cutting Precious Stones.*—The following description is by M. L. de la Tour. This kind of lapidaries' wheel is called, in the Tarmoule language, *couroundum-sane.* It is composed of corundum, more or less finely powdered, cemented together by lac resin; the proportion by volume is two-thirds powdered corundum, one-third lac resin. The corundum powder is put into an earthen vessel, and heated over a clear fire; when of a sufficient heat, which is the case when a small piece of the resin readily fuses, the resin is added in portions, stirring at the time to form an intimate mixture. When made into a paste, it is put on to a smooth slab of stone, and kneaded by being beaten with a pestle; it is then rolled on a stick, re-heated several times, continually kneading it until the mixture is perfectly uniform. It is then separated from the stick, laid again on the stone table, which has been previously covered with very fine corundum powder, and flattened into the form of a wheel, by an iron rolling-pin. The wheel is then polished by a plate of iron and corundum powder; and, finally, a hole is made through the middle, by a heated rod of copper or iron.

These wheels are made of a grain more or less fine; the coarser perform the first rough work, and the finer cut the stones. They are mounted on a horizontal axis; and the workman sitting on the ground, makes them revolve with a spring-bow, which he moves with his right hand, at the same time, with his left, holding the stone against the wheel; the latter being from time to time carefully moistened and powdered with corundum powder. The polish is given by wheels of lead and very fine corundum powder.

It is supposed that this kind of lapidary's wheel may be imitated with advantage in Europe; the powder of emerald or diamond being used in place of that of corundum.—*Mem. du Muséum.* ii. 230.

4. *On a New Piece of Artillery.*—A report was read on the subject of the experiments made at Brest, on the effects of the new kind of artillery, proposed by M. Paixham. The piece (*canon à bombes*) of which trial was made, had a bore eight inches in diameter. The object fired at was an old vessel of eighty guns; each discharge caused such injury as would entirely have disabled it from continuing in action. The fire of the new piece, charged with ten pounds of powder, was much superior to that of a thirty-six pounder having a charge of twelve pounds of powder, at similar angles. The commission was unanimous on the advantages which would be produced by the adoption of this new piece of artillery in the defence of places, and in floating-batteries placed at the entrance of har

bours. It was also equally convinced, that ultimately, they would be introduced on board vessels without inconvenience, and thus have the effect of establishing a sort of equilibrium between vessels of different dimensions. *Proceedings of the Academy of Sciences.*—*Ann. de Chim.* xxvi. 438.

5. *Preservation of Fish during Carriage.*—For ensuring the sweetness of fish conveyed by land carriage, it is proposed, that the belly of the fish should be opened, and the internal parts sprinkled with powdered charcoal.—*N. M. Mag.*

6. *Artificial Puzzolana.*—M. Bruyere finds that an excellent artificial puzzolana may be obtained by heating a mixture of three parts clay and one part slacked lime, by measure, for some hours to redness. M. de St. Leger also finds these proportions to be the best, and prepares the substance for sale.—*Ann. de Mines,* ix. 550.

II. Chemical Science.

1. *On the nature of the Electric Current.* By M. Ampere.—M. Becquerel having constructed an electrometer of excessive sensibility, M. Ampere was desirous of making an experiment with it, illustrative of the nature of the current of electricity produced by contact, and that produced by an electrical machine.

It is well known that when a plate of zinc and a plate of silver are soldered together, and one of them insulated, except by the other metal, a constant difference of electric tension is established between them. The object of the experiment was to verify the supposition that this difference existed even when the two plates were in communication, by being plunged into a liquid conductor; and M. Becquerel found that the tension did not sensibly diminish even when the liquid was acidulated water, and an intense electrical current was produced. This experiment proves that the two electricities developed by contact in the zinc and copper, are produced with a rapidity infinite, as it were, in comparison with the rapidity with which they can traverse acidulated water. It shews also, why no sensible electro-dynamic (electro-magnetic) effect can be produced with a current excited by friction, as for instance, by connecting the conductors of an electrical machine with the wires of the galvanometer. Friction can only excite a certain quantity of electricity in a given time; but the contact of two different metals supplies it *indefinitely* as fast as it is carried off by the fluid conductors: for as fast as they diminish the tension by the removal of the electricity, it is renewed at the point where the two metals are in contact.

It is evident, that, to produce by a machine a current of electricity equal to that produced by a pair of plates, the machine must be competent to produce the same difference of electric tension between two metallic plates, in communication with each other by a stratum of acidulated water, not thicker than that interposed between the two plates which form the voltaic point; but far from observing an effect to this extent, no application of electrical machines has been able to produce an appreciable difference.

"I may observe," says M. Ampere, "that for the observation of a difference of electric tension between two bodies, by the electrometer, it is necessary that the cause which makes the electricities of different kinds pass into the different bodies, should be able also to maintain those bodies in the electric states produced; and prevent the reunion of the electricities, at least for the time requisite to put the electrometer leaf in motion. This circumstance takes place in contact, but not in the union of two bodies; in accordance with the explanation contained in my memoir of Dec. 3, 1823. The combination of two particles can only produce an instantaneous current; and the effects on the galvanometer are observed, because, successive particles combining produce a succession of effects. But in this case no sensible tension should be produced capable of being exhibited by the electrometer, because nothing opposes the union of the two electricities in the liquid where they have been produced; and it is only a portion of these two electric fluids, which, uniting by means of the wire of the galvanometer, produce the effect on the magnetic needle. In accordance with this view, M. Becquerel has observed that the electricity produced by the combination of an acid and an alkali, does not act on the electrometer when the metallic wire which unites these two substances is interrupted, though the current is found by the galvanometer to exist when the wire is continuous.—*Ann. de Chim.* xxvii. 29.

2. *Electromotive Action of Water on Metals.*—M. Becquerel has endeavoured to ascertain experimentally the electrical effects produced by the contact of water and metals. The effect is so small as to be easily mistaken for, or confounded with, those due to electricity produced accidentally during the performance of the experiments, by contact of various parts of the apparatus, or in other ways: but taking every possible precaution, and testing his results in all ways, he arrived at the conclusion that zinc, iron, lead, tin, copper, *&c.* communicated positive electricity to water; whilst platina, gold, silver, *&c.* gave it negative electricity. Water is therefore positive with the metals which are most positive, and negative with those which are least positive. It behaves, therefore, with oxidable metals as alkalies do in their contact with acids, when there is no chemical action. The same phenomena take place even when a

little sulphuric acid is present, and the iron and zinc are acted upon; so that chemical action in this case did not prevent the production of electricity by the contact of metals and water.

By certain changes of the surface, it was found that the intensity of electricity produced was much affected. A plate of gold, plunged in nitric acid for a few moments, and then washed in several fresh portions of water, produced a developement of electricity much greater than before, the water still becoming negative. The same plate, plunged into a solution of potash and then washed, lost in a great measure its power of becoming electrified by contact with water. A plate of platinum offered similar results. It is supposed, that these effects may have a distant analogy with the facts observed by M. M. Thenard and Dulong, that a new platina wire, which would not heat in a current of hydrogen gas and air, acquired this property by being previously plunged for a few minutes in nitric acid, and then washed. The property of the wire continued for above twenty-four hours; and M. Becquerel says, that the plate of gold preserved its power of becoming strongly electrified in contact with water, for several hours.—*Ann. de Chim.* xxvii. 5. (See the phenomena described by M. Yelin. *Quarterly Journal*, v. p. 170.)

3. *On the Electrical Actions produced by the Contact of Flames and Metals.* By M. Becquerel.—In place of making a complete metallic circuit, as in Seebeck's experiment; or one in which the circuit was by water or acid, as in the voltaic pile; the metals used were connected by a flame only, and their states ascertained by the electrometer. The flames used were those resulting from the combustion of alcohol, hydrogen gas, or a sheet of paper. When a plate of platina was placed on the cap of the electrometer, and heated by one of the flames before mentioned, if the temperature was a red heat or above, the metal became negative, but below a red heat it became positive. On trying the electricity of the flame, by making it rise from a piece of wet wood on the cap of the instrument, and holding the platina in it, the reverse, as expected, was found to be the case.

A copper wire gave the same results, and generally it appeared that all the metals had the property just described; thus any metal, plunged into a flame of hydrogen gas, becomes negative or positive according as the temperature is higher or lower, and communicates the contrary electricity to the flame.

If the flame by which the plate of metal on the cap of the instrument is heated, be touched by a piece of wet wood instead of being insulated, the effects are more distinct: but if instead of touching it with wet wood, it be touched with a plate of the same metal as that on the electrometer, the two portions of metal are found in different states: that heated to redness being negative,

and the one heated to a lesser degree positive. The same effects are obtained if the two plates be of different metals. They are also produced if the flame urged by a blow-pipe be used.

These phenomena may be supposed to result either from the friction of the flame on the metals, or from an electromotive action. M. Becquerel inclines to the latter opinion, conceiving it improbable that the tranquil flame of alcohol can produce friction sufficient to suffice for the effect; and not being able to account by friction for the circumstance of two pieces of metal acquiring different electricities in the same flame, according to the temperature. That the effect was not due to the difference of temperature existing in various parts of the same piece of metal, was proved by the entire absence of any electrical phenomena, when a plate of platinum was heated to redness in the focus of M. Fresnel's strong burning glass. These experiments have some relation to that of M. Volta on the combustion of a piece of amadou at the extremity of a rod communicating with the condensing plate of an electrometer. M. Volta found, that when the apparatus was distant from habitations, the amadou became positive by taking electricity from the circumambient air, from which he concluded that the atmosphere had always an excess of positive electricity.

4. *Electrical Phenomena accompanying Combustion.*—M. Becquerel found, that on rolling up a sheet of paper, placing it in the electrometer, inflaming it, and touching the flame with a piece of wet wood that the electricity might flow away more rapidly, the paper became positively electrical. If the experiment were inverted, the paper being held in the hand, and the flame made to touch the piece of wet wood placed on the electrometer, it was found that the flame took negative electricity. Hence it may be concluded, that when paper is burnt, the paper becomes positive, and the flame negative.

If alcohol be burnt in a copper capsule, it is found by the condenser that the capsule becomes electrified positively.—*Ann. de Chim.* xxvii. 14.

5. *On the Light of incandescent Bodies.*—M. Arago gave an account of the experiments which he had made long since on the light which emanated from incandescent bodies. He ascertained that this light, *whether the bodies were solid or liquid*, was partially polarised by refraction, when the rays observed, formed an angle of a small number of degrees with the surface from whence they came. As to the light of inflamed gases, it presented no sensible traces of polarisation under any inclination. M. Arago draws as a consequence from his experiments, that a considerable quantity of the light by which we see incandescent bodies is formed in their interior, at depths which have not as yet been completely deter-

mined. He observes, that the same means of observation may be applied to the study of the physical constitution of the sun; and the results of this kind, which he has already obtained, confirm the conjectures of Bode, Schroëter, Herschell, *&c.—Proceedings of the Royal Academy at Paris,—Ann. de Chim.* xxvii. 89.

6. *Temperature of the Sun*, &c.—M. Dulong communicated a letter from M. Pouillet, in which that philosopher announced, that he was occupied with experiments relative to the measure of very elevated temperatures, such as those on the surface of incandescent bodies, or bodies in ignition, of flames, and particularly of the sun. The instrument used by M. Pouillet to obtain these results is founded on the properties of radiant heat, and principally on this datum; that a body, the bulb of a thermometer for instance, perfectly insulated in the midst of a sphere of ice, but so placed as to receive the rays of the sun through a circular aperture of such a form and position, that all the lines forming tangents to the sun and the ball may pass through it, will be heated precisely in the same manner as if it were supposed that a portion of the surface of the sun, or of a body heated to the same temperature exactly filled the aperture in the ice. M. Pouillet, among other results, states, that the temperature of the sun thus determined is 1400 degrees (2552° F.)—*Proceedings of the Society of Pharmacy of Paris.—Jour. de Pharm.* 1824, 415.

7. *Security of Steam Engines.*—The Royal Academy of Paris, has been called upon by the government, to report on the means proper to be adopted for the prevention of accidents and injury from the explosion of steam-engine boilers. The means proposed had the double object of preventing the rupture of the boilers, or in case of their destruction, preventing injury to neighbouring buildings. They directed that the boiler should be proved by the hydraulic press, with a force five times that which they would have to bear during the working of the engines: that a safety valve should be attached to the boiler and locked up, the valve being so loaded as to open at a pressure just above that by which the boilers have been tried: that the boiler should be surrounded by a wall of masonry one metre (39.371 inches) in thickness; an interval of a metre being left between the boiler and the wall, and again between the wall and the neighbouring buildings. Another precaution has been added by M. Dupin, and adopted by the Academy; namely, the introduction of a metallic plug into the upper surface of the boilers, formed of such an alloy as should melt at a temperature a few degrees above that at which the engine is intended to work.

In consequence of this application, it became necessary to form a table of the pressure and temperature of vapour. The academy appear very doubtful of estimations as yet published, but give the

following table up to eight atmospheres, as nearly correct: above that they say it was impossible to go without farther experiments.

Elasticity in atmospheres.	Height of mercury.	Temperature of Fah.	Pressure on a square inch.
1	29.92 in	212°.0	14.61 lbs. avoir.
1½	44.88	234.0	21.92
2	59.84	251.6	29.23
2½	74.80	264.2	36.44
3	89.76	275.0	43.84
3½	94.73	285.3	51.15
4	119.69	293.4	58.46
4½	134.65	302.0	65.76
5	149.61	309.2	73.07
5½	164.57	316.4	80.37
6	179.53	322.7	87.69
6½	194.49	328.5	94.99
7	209.45	334.4	102.30
7½	224.41	339.3	109.60
8	239.37	343.4	116.92

It is advised, that no direction should be given for the composition of the fusible plugs or plates, but their preparation intrusted to some competent person who should be responsible for the accuracy of their fusing points. The fittest place for them, all things being considered, is the upper surface of the boiler. Their proper diameter and thickness have not yet been ascertained; they should be such as to bear the force of the vapour without risk of breaking; and when the plate is fused, to leave an aperture sufficient for the ready escape of the vapour.—*Ann. de Chimie*, xxvii. 95.

8. *Preparation of Damasked Steel.*—M. Breant has been engaged in numerous series of experiments on the production of steel of various qualities, and particularly damasked, like that of which the oriental blades are made; and the conclusion he has arrived at, is, that the damask is produced, not by welding together wires and rods of steel, and twisting them in various directions, but by using a fused or cast steel more carburetted than the steels of Europe; and in which, by the effect of slow cooling, a separate crystallization of two distinct combinations of iron and carbon has been effected, which separation is the essential condition to the production of a damask.

If iron be united to a small proportion of carbon, insufficient to convert the whole into steel, and the fused mass be cooled slowly, the steel and the iron will partly separate from each other, and the metal will, when properly treated, exhibit a white damask. A further proportion of carbon will convert the whole into steel, which, when solid, will not exhibit any appearance of separation among its

parts. More carbon will produce a mixture of two substances, one steel, the other carburetted steel analogous to cast-iron; these, by slow cooling, will partially separate, and the mass of metal is then capable of exhibiting a damask, the pure steel appearing of a black colour, the extra carburetted parts white.

As the separation of these substances must be proportionate to the length of time which elapses before the fused metal solidifies, M. Breant states, that it is sometimes proper to avoid the fusion of masses so large as to be long in cooling; and quotes a passage from Tavernier, who, in his travels in Persia, says, that the fused pieces of steel which come from Golconda, when worked, are not larger than a roll.

The more carbon the steel contains, the more difficult is it to forge. Most of those prepared by M. Breant could only be worked at temperatures, of which the extremes were very limited; at a white heat they crumbled under the hammer, at a cherry-red heat they became hard and brittle. The latter tendency, augmented in proportion to the diminution of temperature, and to such an extent, that once below a red heat, they would, if tried with a graver or file, be found much harder and more brittle than when quite cold.

M. Breant remarked, that 100 of soft iron and 2 of lamp-black fused as readily as common steel; and gave a compound, from which excellent damasked blades were made. He considers it unnecessary, therefore, to cement the iron with carbon as a preliminary step in the manufacture of steel. Another specimen of steel was made by fusing together 100 parts of very grey cast iron in filings, and 100 parts of the same filings previously oxidated. This steel was very elastic, and had a beautiful damask. The result was such as to convince M. Breant, that steel might be made on a large scale in reverberatory furnaces from the best grey pig iron, by adding to the metal in fusion a portion of the same metal oxidated, or native oxide of iron.

Although M. Breant's results are by no means opposed to those obtained by Messrs. Stodart and Faraday, yet he thinks it probable they may have drawn erroneous conclusions, and attributed to the presence of alloying metals, the effects really due to a greater proportion of carbon. It may, perhaps, therefore, be as well to state, that every source of carbon was carefully excluded in their experiments. The tilted cast steel, and the alloying metal being carefully preserved from contact of any other substance than the crucible and the plug of lute, which with the cover, *&c.*, were used to confine it.—*Annales des Mines*, ix. 319.

9. *On the Scales of Iron.*—M. Berthier has lately examined the scales of oxide, which form on iron when heated; and after careful analytical experiments, is induced to consider them as a new oxide. They are brittle, very magnetic, sp. gr. 3.5 at least, and

yield a dull greyish black powder. They do not unite with acids forming particular salts, but are resolved into protoxide and peroxide, these forming salts with the acids. These scales were not always of the same degree of oxidation, but when most constant, gave

Iron	745	or	100
Oxygen	255		34.2

"I believe," says M. Berthier, "that this is the true composition of these scales, and that henceforth we must reckon upon four oxides of iron in which the oxygen is as the numbers 6 : 7 : 8 : 9.

The first is the protoxide—the second, the scales in question—the third that obtained by passing steam over red-hot iron or the natural magnetic oxide, and the fourth, the peroxide.—*Ann. de Chim.* xxvii. 19.

10. *Reduction of Oxide of Iron by Cementation.*—M. Berthier lined some crucibles with charcoal, and put into each about 1500 grains of finely pulverised iron scales; the crucibles were filled with charcoal, well closed, luted, and heated for various periods of time, from half an hour to three hours. When cold they were examined; the ferruginous substance had adhered together without any change of form or volume; the masses were enveloped in a layer of metallic iron, and the oxide in the centre, more or less in quantity according to the time the crucibles had been in the furnace, had undergone no alteration. The metallic layer was in some cases nearly 0.2 of an inch in thickness; it had a very particular appearance, was dull and granular in its fracture, and of a clear olive grey colour. It acquired a bright polish from the friction of hard bodies; might be cut with scissors, and in this way reduced to very fine powder; it was as soft as lead, quite inelastic; when struck with a hammer, it flattened and took the form of the face of the hammer. Its specific gravity was not more than one-third that of pure forged iron. It was pure iron extremely divided, and in a state analogous to that of spongy platinum.

A section of a mass which had undergone long cementation, presented the following order of things from the surface to the centre; 1. A very thin layer of metallic iron of a deep blue or black colour; 2. A thick layer of the olive green iron of an uniform colour; 3. A layer with shades of olive green and black, passing into the pure black and slightly metallic appearance of the scales themselves. The first appeared to be slightly carburetted, and to approach to the state of steel. The second was iron of the greatest purity. The third, or olive green and black part, was a mixture of iron and oxide, for it always gave red oxide by treatment in the humid way; and this fact proves, says M. Berthier, that metallic iron exerts no action on the oxide of scales, and consequently that a protoxide cannot be obtained by the action of iron on any other oxide of iron whatever.

When peroxide of iron was thus cemented, similar and other interesting results were obtained. When the mass was not large, so long as red oxide remained at the centre, no metallic iron was produced at the surface, but only black oxide. After a sufficient length of time, magnetic oxide only was found at the centre, and iron appeared at the surface. It appears, that the peroxide is first changed into magnetic oxide, and as soon as that has taken place, the reduction is propagated from the surface to the centre, so that whilst metallic iron is forming at the surface, the deutoxide (or scales) is forming in the interior even to the very centre; and that, ultimately, even a layer of steel is produced at the surface.

Then arises the question, how are these effects produced? How is it that the oxide is reduced without any contact of carbon? To prove that it could not be occasioned by the percolation of the vapours of the furnace through the porous mass of oxide generally, various experiments were tried with the charcoal in different parts of the mass; the effect was always found to commence at the charcoal and proceed from it.

The oxidation of iron to the depth which takes place in cases where the metal is heated for a long time, is to M. Berthier as inexplicable as the case of reduction; for he remarks, as soon as a coat of oxide is formed, it protects the iron from further contact of air like a varnish; and it must therefore be admitted, that the iron attracts the oxygen through the oxides, just as the oxides attract the carbon through the metallic iron.—*Ann. de Chimie*, xxvii. 24.

Analysis of Meteoric Stones and Iron found in Poland. By M. Laugier.—The specimens examined were received by M. Brongniart from M. Horadecki, of Vilna; they had fallen at different times in Poland, and M. Laugier found them perfectly consistent in their results with the results he had obtained from other aërolites. He first describes the general mode of analysis, which appears to him most applicable to these bodies: this consists of two processes, one by alkali, the other by acid—fuze in a silver crucible 100 parts of the aërolite and 400 hydrate of potash; dissolve in water, allow the solution to settle, decant and wash the insoluble portion with hot water. The solution will contain oxide of manganese, chromate of potash, silica, and a little alumina: if it be green boil until yellow, filter and collect the deposit. Concentrate the solution to one half, supersaturate with weak nitric acid, precipitate by protonitrate of mercury, leave it to settle, decant the liquor and put the deposit into a crucible; wash it with water until it has no taste, dry the precipitate, calcine it, and weigh the oxide of chrome. Evaporate the decanted solution, heat to bright redness, re-dissolve in water, and the silica and alumina will be left, which may be separated in the usual way.

The moist portion insoluble in the alkali, is to be dissolved in mu-

riatic acid, and evaporated to dryness to separate the silica; then filter and wash the silica with weak muriatic acid, and precipitating the solution by ammonia, boil and separate the oxide of iron. Evaporate the ammoniacal solution until its blue colour changes to green, put in a few drops of hydrosulphuret of ammonia, and collect on a filter the black precipitate of hydrosulphuret of nickel. After having evaporated the solution until colourless, precipitate the lime by oxalate of ammonia, and the magnesia by caustic potash.

The second process, by acid, is intended to determine the quantity of sulphur and alkali only. To one part of the aërolite add sixteen parts of muriatic acid, diluted with an equal volume of water: heat this mixture in a tube or flask, conducting the gas liberated into a solution of acetate of lead or copper; continue the heat until no more sulphuretted hydrogen is liberated; then collect, wash, dry, and weigh the sulphuret formed. Filter the muriatic solution, pass chlorine through it to convert the iron into peroxide, precipitate the iron by ammonia, evaporate the solution to dryness, and heat it strongly. Any residue must be dissolved in water, and tested for alkali by solution of pure platina.

The stone first examined fell June 30, 1820, at Lexna, near Dunabourg, at the mouth of the Duina. It resembled most other aërolites. When pulverised it gave about a fourth of its weight of brilliant globules, attracted by the magnet, and dissolving in weak muriatic acid, with the evolution of sulphuretted hydrogen; 100 parts containing the globules gave

Oxide of iron	40
Silica	34
Magnesia	17
Sulphur	6.8
Alumina	1
Nickel	1.5
Chrome	1
Lime	0.5
Traces of copper and manganese	

The second aërolite fell 30th March, 1818, at Zaborzyca, in Volhinie. It was easily pulverised, and did not contain the globules found in the preceding stone: 100 parts gave

Oxide of iron	45
Silica	41
Magnesia	14.9
Sulphur	4
Lime	2
Nickel	1
Alumina	0.75
Chrome	0.75
Traces of manganese	
	109.40

These meteorolites contain not more than a fourth of the quantity of nickel usually found in similar bodies.

In 1817 M. Laugier published a memoir on the identity of the origin of the native iron of Siberia and meteoric stones, and announced the presence of chromium and sulphur in that iron, as well also as the presence of silica and magnesia. Since this he has been anxious to ascertain whether other specimens of iron, either presumed, or known, to be meteoric, exhibited the same similarity as to the elements they contained with those of meteoric stones.

The two specimens of Polish iron were found in 1809, at Brahin, in the district of Rziezyca-Minsk. It resembled the Siberian iron in appearance; being full of cavities, covered internally with a yellowish green vitreous substance: 100 parts of the blue variety treated with muriatic acid, and the sulphuretted-hydrogen disengaged passed into solution of lead, gave 12 of sulphuret equal to 1.75 sulphur. The acid solution heated, the iron peroxidized by nitric acid, and precipitated by ammonia gave 120 parts, equal to 87.35 iron. The blue ammoniacal solution, heated until the free ammonia was disengaged, was treated with caustic potash, which threw down 7 parts of nickel, magnesia, and lime; these were heated with an excess of oxalic acid, and the oxalates thus formed being digested in ammonia, the salt of nickel dissolved, and from the solution 2.5 parts of protoxide were obtained: the insoluble oxalates of magnesia and lime, being heated, and acted upon by sulphuric acid, gave sulphate equal to 2.1 of magnesia, and a little sulphate of lime.

Seven and a half parts had been left undissolved by the muriatic acid; these were of a yellowish white colour, and by calcination took a rose tint; fused with potash, the alkali immediately became yellow, and from the results were obtained 6.3 of silica and 0.5 of oxide of chromium.

Hence 100 parts of the Brahin iron contain

Iron	87.35
Silica	6.30
Nickel	2.50
Magnesia	2.10
Sulphur	1.85
Chromium	0.50
	100.60

So that this iron exactly resembled that from Siberia.

The other variety of Brahin iron was white; and with the exception of chromium, which could not be found in it, resembled the former 100 parts gave

Iron	91.5
Silica	3.0
Nickel	1.5
Magnesia	2.0
Sulphur	1.0
	99.0

Mem. du Museum, ii. 89.

12. *On the Presence of Titanium in Mica.*—M. Vauquelin has repeated the experiments of M. Peschier, of Geneva, on the existence of titanium in mica; and has found that metal in all the varieties of mica examined, though, where most abundant, it never amounted to one per cent. M. Vauquelin's process was as follows: the mica divided into very thin plates, and cut by scissors, was heated for half an hour with two parts of caustic potash; the mixture was diffused through 100 parts of water, (generally yielding a green solution from the presence of manganese,) and muriatic acid was added until in slight excess, which caused solution of the whole, if the fusion with potash had been well performed. The solution was slowly evaporated, especially towards the last, and a powder obtained, either white or coloured, according as iron was absent or present. This powder, thrown on a filter, was washed first with cold and then with hot water. If the silica remaining was coloured, it was acted upon by cold muriatic acid, diluted with ten of water, until white; thus freed from iron, it was afterwards boiled in strong muriatic acid, and the solution diluted, filtered, and evaporated; when almost all the acid was driven off, the liquid was again diluted, and tested by infusion of galls. If titanium were present, a reddish yellow precipitate took place after some hours, of tannate of titanum. M. Vauquelin also examined the washings, but the operation, &c., if well performed, always gave titanum with the silica, if any were contained in the mineral.—*Ann. de. Chim.* xxvii. 67.

13. *Decomposition of Metallic Sulphates by Hydrogen, by* M. Arfwedson.—The apparatus used in these experiments was a tube of difficultly fusible glass, in the middle of which was blown a bulb to contain the sulphate operated upon. The hydrogen or sulphuretted hydrogen used was dried by chloride of calcium.

Dried *Sulphate of Manganese* was not affected by the hydrogen, until at a dull red heat; it then gave water and sulphurous acid, and became brown: when cold, a green powder was obtained, dissolving without effervescence in muriatic acid, and evolving sulphuretted

hydrogen; the solution was not affected by salts of baryta. 100 parts of the dry salt lost 47.22, and as in consequence of the liberation of sulphurous acid, it could not have produced a simple sulphuret nor a sub-bisulphuret, the loss not being sufficient; it was suspected to be a compound of sulphuret and oxide, like crocus of antimony. This was proved by passing sulphuretted hydrogen over it, for water was formed, and the whole converted into simple sulphuret. The oxy-sulphuret of manganese is green, unaltered by air, distinguished from the sulphuret by its brighter colour and greater difficulty of oxidation in the air by heat. It is composed of

Manganese	70.26	or	Sulphuret of Manganese	55
Sulphur	19.86		Oxide of Manganese	45
Oxygen	9.88			
	100.			100

When protoxide of manganese, or sulphate of manganese, is reduced by sulphuretted hydrogen, a sulphuret is obtained, containing one atom of manganese, and one atom of sulphur.

Sulphate of Zinc, heated in hydrogen, gave sulphurous acid and water; and left a pulverulent yellow substance, containing both sulphuret and oxide of zinc, but no sulphuric acid. Sulphuretted hydrogen caused the liberation of water, and left a sulphuret. One hundred parts of sulphate gave in three experiments 56.07, 58.23, 56.95. Here the weight of the oxy-sulphuret is too much; and we must conclude, that when decomposed in this way more than half becomes sulphuret, and the rest oxide, but without any constant proportion being observed. The native sulphuret of zinc contains

One atom zinc . . .	66.34
One ditto sulphur . .	33.66
	10.00

Sulphate of Cobalt, gave sulphurous acid and water, and left per cent. 53.62 of oxy-sulphuret; so that half of the sulphate becomes sulphuret and half oxide. When sulphate of cobalt is decomposed by sulphuretted hydrogen, a sulphuret is produced, containing more than one atom of sulphur, and apparently composed of an atom of simple sulphuret, and an atom of sesqui-sulphuret.

Sulphate of Nickel, is readily decomposed by hydrogen, at first giving off water and sulphurous acid; and ultimately sulphuretted hydrogen. 1015 of sulphate left 490 of a pale yellow coherent metallic substance, attracted by the magnet, and with marks of fusion here and there. When analyzed, it proved to be a compound of two atoms nickel, one atom sulphur.

Oxide of nickel, with sulphuretted hydrogen, gave a pulverulent dark grey substance, not attracted by the magnet, and more infusible than the sub-sulphuret. 1186 of oxide gave 1438 of sul-

phuret hence it is composed of an atom of each element. The natural sulphuret is formed of

Sulphur . .	34.26
Nickel . .	64.35

Proto-sulphate of Iron. Treated with hydrogen, it yielded first water and sulphurous acid; then sulphuretted hydrogen; and left a pulverulent grey mass readily attracted by the magnet, soluble in muriatic acid disengaging sulphuretted hydrogen, and containing no sulphuric acid. 100 parts of anhydrous sulphate gave 46.82 of this sub-sulphuret; and 367 of this compound, heated with sulphuretted hydrogen, increased 107 parts, without the production of any water. The first compound is, therefore, a new sulphuret of iron, a true sub-sulphuret, containing an atom of sulphur and two of iron. The augmentation of weight by sulphuretted hydrogen is more than sufficient to convert it into the simple sulphuret, and is just such as would give a compound of one atom bisulphuret plus six atoms sulphuret, which is the same composition as that Stromeyer gives for magnetic pyrites.

Sub-proto sulphate of Iron—obtained by adding a little alkali to the sulphate, and which contains two atoms base and one acid, when acted upon by hydrogen, loses half its sulphur, all its oxygen, and becomes a sub-quadrisulphuret, containing four atoms of iron and one of sulphur.

Sulphate of Lead, with hydrogen, produces a mixture of sulphuret of lead and lead. It appears from the analysis that half the sulphate was entirely reduced, and the other half converted into sulphuret. It is not considered as probable that hydrogen would entirely decompose the sulphate, leaving pure lead, since Berthier found that carbon could not effect this change.

The sulphates of copper and bismuth, by hydrogen, left the pure metals. The sulphate of tin gave tin, with a little sulphur; and the sulphate of antimony, a mixture of antimony, oxide, and sulphuret.—*Ann. de Chimie,* xxvii. 177.

14. *Cyanate of Potash and Cyanic Acid, of Wöhler.*—Wöhler prepares what he calls cyanate of potash, in abundance, by making a mixture of equal parts of anhydrous ferrocyanate of potash and per-oxide of manganese, and heating it to dull redness. If too strongly heated, but little salt is obtained; because the deutoxide of manganese formed appears to be changed into protoxide at the expense of the cyanate. The mass is to be boiled in dilute alcohol, containing about fourteen per cent. of water; and on cooling the salt separates in small plates, like chlorate of potassa. It is insoluble in pure alcohol.

429 of the anhydrous cyanate of potash, decomposed by muriatic acid gas and heat, produced abundance of muriate of ammonia, and left 400 of chloride of potassium, equal to 253 of potassa;

the cyanate, therefore, contained 58.97 per cent. of potash. In another experiment, 764 of the salt, decomposed by muriatic acid, in a crucible, gave 700 of chloride, corresponding to 57.96 per cent. of potash in the salt.

When the aqueous solution of the cyanate is boiled, it becomes entirely converted into carbonate of potash: 380 of the cyanate, moistened in a platina crucible, dried and heated to redness, and this again repeated, gave 323 carbonate of potash, much ammonia being disengaged. According to this experiment, 100 of the cyanate contains 57.95 of potash.

Cyanate of Silver is insoluble in cold water, slightly soluble in boiling water, but separating in powder as the solution cools. 680 of the cyanate, heated until reduced, gave 490 of metal, equal to 526 oxide; consequently 100 of cyanate of silver contains 77.353 oxide of silver. During the operation no ammonia was perceived, proving the dryness of the salt.

For the analysis of the cyanic acid, advantage was taken of the property possessed by the cyanates of liberating all their carbon as carbonic acid, when treated with acids in solution in water. 36 parts of cyanate of silver were made into a ball, and introduced into a glass tube over mercury, with weak muriatic acid; fifty-three cubic centimetres of carbonic acid gas were instantly evolved, equivalent to 2.86 of carbon, which must have been furnished by 8.197 of cyanic acid, that being the quantity contained in the salt of silver used. According to this experiment, 100 of cyanic acid contains 34.922 carbon, and 40.83 nitrogen. The experiment repeated with a very pure cyanate of silver, gave for 100 of the acid, 35.315 carbon, and 41.289 nitrogen.

The quantity of oxygen contained in the cyanic acid is obtained, by subtracting from the weight of the cyanate of silver the weight of the products already obtained; and it is then found to be exactly equal to that combined with the silver; so that the cyanic acid is composed of

	by experiment.	calculation.	atoms.
Carbon	35.334	35.294	2
Nitrogen	41.317	41.177	1
Oxygen	23.349	23.529	1
	100.000	100.000	

or,

Cyanogen	76.471	1 atom.
Oxygen	23.529	1 atom.
	100.000	

from which it would appear that cyanic acid is composed of an atom of cyanogen, and an atom of oxygen; and, consequently, in cyanates, contains as much oxygen as is contained in the base.

The editor of the *Annales de Chimie* observes upon this analysis, that the acid is composed of the same elements and in the same proportions, as that described by MM. Liebig and Gay-Lussac, as fulminic or cyanic acid; but that, as the two substances differ entirely in their properties, one must be obliged to admit that the elements are combined in different ways. The subject, however, he observes, requires further examination.—*Ann. de Chim.* xxvii. 190.

15. *Boron, its preparation*, &c.—The readiest method of obtaining boron, without losing too much potassium, is to heat the potassium with fluo-borate of potash*. Boron and silicium resemble each other in their properties nearly as sulphur and silicium, or as phosphorus and arsenic. I have produced sulphuret of boron; a white and pulverulent substance, which dissolves in water, yielding sulphuretted hydrogen gas. Boron burns in chlorine. The chloride of boron is a permanent gas which is decomposed in moist air, producing a dense vapour; and in water giving muriatic and boracic acids. It condenses one and a half times its volume of ammoniacal gas. *Berzelius—Bib. Univ.* xxvi. 277.

16. *Action of Alum on Vegetable Blue Colours.*—It is commonly stated in chemical works, that a solution of alum has the property of reddening vegetable colours. With the exception of litmus, where the effect is very *decided*, and of tincture of cabbage, where the effect is *trifling*, a contrary effect is experienced; the solution has turned the colours (which were generally obtained from the blue petals of flowers) green. H. B. Lekson.

17. *Preparation of Lithia.*—M. Berzelius says, the most economical way of preparing lithia is to mix the triphane, or spodumene, in powder, with twice its weight of pulverized fluor spar, and with sulphuric acid; then to heat the mixture until the fluoric acid with the silica is volatilized, and afterwards to separate the sulphate of lithia by solution.—*Bib. Univ.* xxvi. 279.

18. *On Sulpho-iodide of Antimony, by* MM. Henry *and* Garot.—When very dry iodine and sulphuret of antimony are mixed in equal parts, and sublimed in dry vessels by the moderated heat of a sand-bath, red vapours appear, which condense on the upper and cooler parts of the vessels, whilst a greenish-grey mixture of protoxide of antimony with a little iodide and sulphuret remains.

The condensed volatile substance appears in brilliant translucid plates, resembling fern-leaves in form, of an intense poppy-red colour; if the vessels in which the sublimation has been made

* See Preparation of Silicium, p. 157.

are large, the crystals appear as prismatic prisms. When heated, they readily fuse, and by careful management may be repeatedly sublimed; but when highly heated, iodide and sulphur are set free, sulphurous acid is formed, and a mixture of antimony and oxide produced. The crystals have a sharp disagreeable taste: light has no action on them. When put into alcohol or ether, iodine is dissolved, and a yellow sulphuret of antimony deposited. When put into water, hydriodic acid, protoxide of antimony, and sulphur are formed. The action of the acids is such as might be expected, decomposition of the substance being always produced.

Upon analysis, this substance gave as its elements, antimony 23.2, iodine 67.9, sulphur 8.9, which nearly corresponds with one proportional of each substance. The authors have called it a Sulpho-iodide of Antimony.—*Jour. de Pharmacie*, x. 511.

19. *Glass of Antimony.*—This substance contains, according to M. Soubeiran—

Protoxide of antimony	91.5
Silica	4.5
Peroxide of iron	3.2
Sulphuret of antimony	1.9
	101.1

20. *Conversion of Oxalate and Formiate of Ammonia into Hydrocyanic Acid.*—Professor Dobereiner has proved, by experiment, the occurrence of a phenomenon, the possibility of which he had previously inferred. It is, the conversion of the oxalate of ammonia into cyanogen and water. If this salt be mixed with oxalate of manganese, and heated by a spirit lamp in a glass tube closed at one end, we obtain, besides carbonic oxide and carbonate of ammonia, water and cyanogen, but the cyanogen is speedily converted, by the action of the carbonate of ammonia and water, into hydrocyanic acid.

The formiate of ammonia decomposed in a glass retort, is also converted into hydrocyanic acid and water.—*Phil. Mag.* lxiv. 234.

21. *On the Detection of Hydrocyanic Acid in the Bodies of Animals poisoned by it.*—The Report on a Memoir by M. Lassaigne on this subject, states; that having prepared the pure hydrocyanic acid, according to M. Gay Lussac's method, it was diluted with five times its weight of water to retard its spontaneous decomposition. A ten thousandth of this acid in water could be detected by persulphate of iron, *i. e.*, a grain of the diluted acid being added to eighteen ounces of water was rendered sensible by the action of the ferruginous salt.

This test, although very delicate, is surpassed by another, in

which copper is used, and which will detect the $\frac{1}{20000}$ of the hydrocyanic acid in solution in water. The mode of operation is to render the liquid containing the hydrocyanic acid, slightly alkaline with potash; add a few drops of sulphate of copper, and afterwards sufficient muriatic acid to re-dissolve the excess of oxide of copper. The liquid appears more or less milky, according to the quantity of hydrocyanic acid present. A singular property of the precipitate thus diffused through 20,000 parts of water, is, that after some hours it re-dissolves, especially if the muriatic acid added be in sensible excess.

Nitrate of silver is also a good re-agent for detecting hydrocyanic acid, but the appearance too much resembles that produced by the presence of muriatic acid.

A cat was poisoned by twelve drops of the hydrocyanic acid in sixty drops of water; the animal died one minute after having swallowed the poison. At the moment of its death a vapour came from its throat smelling strongly of the acid, and a paper moistened with alkali when held to it was afterwards rendered blue by persulphate of iron. The animal was retained at the temperature of 50° F. for eighteen hours, and then opened. The odour of prussic acid was readily perceived in the brain, spinal marrow, and thoracic organs. It was but slightly sensible in the stomach, which contained nothing but mucus; but on cutting the organ in pieces it was developed. The stomach was cut into pieces under water, and distilled with the water; when about an eighth of the liquid had passed over, it was mixed with potash and per sulphate of iron, and soon gave a feeble blue tint, leaving no doubt of the presence of hydrocyanic acid. The test by copper gave it still more sensibly. The copper tested prussic acid also in the intestines, but the persulphate of iron did not.

The experiments repeated on a young cat with one drop of the acid gave the same results.

A dog being poisoned by twelve drops of the acid died in half an hour. The body was opened fifty-three hours after death, and both the contents of the stomach, and the stomach itself, distilled as before, gave by sulphate of copper decided proofs of the presence of the prussic acid.

Four drops diluted with water were injected into the rectum of a young cat; forty-eight hours after death the intestine was extracted and examined, and gave evidence of the presence of the poison.

M. Lassaigne observes that, when the quantity of hydrocyanic acid is very small, its presence is not shewn by the sulphate of iron, until twelve or even eighteen hours after its addition, whilst the sulphate of copper discovers it immediately; and that the effect of the latter had frequently disappeared before the first had become evident. The experiments indicate, 1. That, from a ten thousandth to a twenty thousandth of hydrocyanic acid may be

discovered in solution in water; 2. That, when animals have been poisoned by hydrocyanic acid, traces of the poison may be discovered in them from eighteen to forty-eight hours after death; 3. That, it is always in the parts into which the poison has been introduced, that it may be discovered; 4. That, it has as yet been impossible to shew the existence of the poison in the brain, the spinal marrow, or the heart, although these organs evolve an odour sufficient to excite suspicion of its presence.—*Ann. de Chim.* xxvii. 200.

22. *Purification of Vinous Liquors, from Fruits.*—M. Cadet de Vaux states, that the very different products obtained by distilling the fermented liquors of various kinds of mellow and sweet fruits, may be purified and rendered almost identical with each other, by re-distilling the product with milk. As an instance, he quotes the comparison of a liquor he obtained from plums, as compared with the *kirschwasser* or cherry water of the best kind. The plums, when fermented, gave a wine, which being unfit for the market, was distilled; but the product obtained was weak, was precipitated white by water, and was very inferior in flavour and value. On adding milk to it, when put into the still a second time, the latter instantly curdled; and when the distillation was completed, the product was found to be so good and excellent in its flavour and other qualities as to deceive the best judges, who took it for real cherry water, as made directly from cherries.—*Bulletin des Sciences.*

23. *On the preparation of Morphia.*—The following process, by M. Hottot, appears from the description, far to surpass any other that has yet been recommended, both for the readiness with which pure morphia is obtained, and the quantity of the product. Opium is to be dissolved in so much water, as to yield a solution of a specific gravity not higher than 1012; a small quantity of ammonia is then to be added, just sufficient to precipitate the colouring matter of the solution. In consequence of the diluted state of the liquor this readily falls to the bottom; the clear solution is then removed and more ammonia added to it to precipitate the morphia. The alkali separates, and falls upon standing as a crystalline sediment, containing very little colouring matter; this washed with cold water and afterwards treated by alcohol of sp. gr. 847 or 837, and a little animal charcoal, according to its quantity, gave, by the first operation, a morphia so pure that it required no further solution in alcohol or in sulphuric acid. By this process a considerable quantity of morphia may be obtained in twenty-four hours, with very little expense of alcohol; and the only point necessary to be attended to, is to separate carefully the fatty matter, which falls in the first instance, on adding a small quantity of ammonia, so that

it may not be re-dissolved by the addition of the further quantity of alkali necessary to precipitate the morphia.

It was found that the product from the magnesian process was rarely so white and pure as that furnished by the above method; and in comparative experiments the ammonia process yielded the largest result. The quantities of substances used are given as follows:—macerate a kilogramme (35oz. 5dr.) of opium in sufficient cold water to exhaust the residuum, evaporate the liquors until of specific gravity 1012, or nearly so; when half cooled, add to the solution so much ammonia as will make it neutral or very slightly alkaline, about eight grammes, (123.5 gr.) allow the precipitated matter to separate; decant, and again add ammonia in sufficient quantity, about 64 grammes; (988.5 gr.) leave it for about twelve hours to deposit, throw the precipitate on a filter, wash it with cold water, and then treat it with three kilogrammes (6lb. 10oz.) of alcohol of sp. gravity .847, and sixty-four grammes (988.5gr.) of animal charcoal; heat it in a sand bath, and when the alcohol boils filter it; as it cools the morphium will crystallize, amounting in weight to from 350 to 472 grains. The alcohol, rectified, will serve for further operations.—*Jour. de Pharmacie*, x. 475.

24. *Active principle of Belladonna.*—M. Runge has ascertained that the narcotic principle of Belladonna is destroyed, or so changed, by alkaline solutions, as to lose its distinguishing property of causing dilatation of the pupil: this takes place when the solutions are weak, or even with lime water; so that this principle cannot be obtained by the usual process, alkaline substances being used. Magnesia, however, was found not to exert any action of this kind, and may therefore be resorted to in the process, but it is very advantageous to use it as a hydrate, and not calcined. It should be thrown down from sulphate of magnesia by potash, not in sufficient quantity to decompose the whole of the salt, the mixture added to the aqueous infusion of belladonna, and the whole evaporated by a brisk fire to dryness; the residue, which is readily dried and pulverized, is to be treated with highly rectified boiling alcohol. The clear yellow solution is to be evaporated spontaneously, and a crystalline mass is obtained, which slightly blues reddened litmus paper, dissolves in water and produces extreme dilatation of the pupil. The salts formed by it with sulphuric, muriatic, and nitric acids, also produce the same effect on the eye.—*Ann. de Chim.* xxvii. 32.

25. *On the active principle of Colocynth—Colocyntine.*—The following account is abstracted from a paper, by M. Vauquelin:—Colocynth treated with alcohol, yields the bitter substance much purer than when water is used. The alcoholic solution evaporated,

yields a very brittle substance, of a gold yellow-colour, which when put into cold water produces a solution, whilst white opaque filaments remain, which ultimately form a soft semi-transparent yellow mass resembling some resins. If the aqueous solution be heated, it becomes turbid, and there form, both on its surface and at its bottom, yellow drops, resembling a fused resin; these, when cold, become hard and brittle. The solution re-heated, is again rendered turbid, and this effect is produced until the whole is evaporated.

It is found on examination, that the substance remaining undissolved by the water at first, is of the same nature as that dissolved, and may itself be dissolved in abundance of water. It appears that the first portion of water dissolves more than the second or third, from the presence probably of some acid taken up by it. A yellowish-brown extractive matter also appears to be present; for the first solution is much more coloured than the second, and the product of the second solution evaporated, appears to be much purer than that of the first. If by successive evaporations the resin-like substance be separated, the last, or mother liquor, contains a substance considerably soluble in water, and but slightly troubled by infusion of galls; the turbidness is occasioned probably by the presence of the bitter substance, a portion as is evident to the taste remaining.

The bitter resin-like substance is slightly soluble in water; considerably so in alkaline solutions; abundantly precipitated by infusion of galls, but not at all by acetate of lead. When heated it yields a white vapour, of which the taste is not bitter, and leaves a very bulky charcoal. Nitric acid dissolves it, and the acid is decomposed, acting upon the substance, although with difficulty. If the solution be diluted, part of the substance precipitates in very bitter white flocculi.

This substance, containing the bitterness of the colocynth, appears to M. Vauquelin to be a particular principle. It is very soluble in alcohol, less so by far in water, but giving a solution of extreme bitterness and frothing on agitation. He proposes for it the name of *Colocyntine.—Jour. de Phar.* 1824, 416.

26. *Active Principle of the Daphné Alpina.*—The following conclusions have been arrived at by M. Vauquelin, in consequence of experiments on this plant.

1. That the irritating principle of the daphnés is a volatile oil.
2. That it is during the vegetation of the plants, when they contain most of the volatile oil, that they possess most energy.
3. That this oil being gradually converted into resin, the irritating powers of the plant diminish in proportion.
4. That a certain quantity of resin being formed, defends the rest of the oil, from a similar change, and that it is in consequence of this circumstance that old plants retain, to a certain degree, the power of acting on the skin.

5. That this oil, as well as the acid accompanying it in infusions of the plants, is precipitated by acetate of lead, from which precipitate it cannot be separated by sulphuretted hydrogen.

6. That, nevertheless, this same oil may be separated from the sulphuret of lead by means of boiling alcohol, but that it remains combined with sulphur.—*Jour. de Phar.* 1824, 424.

27. *Preservation of Red Cabbage Colour.*—Digest the leaves of the cabbage in warm alcohol; distil off the alcohol from the coloured solution obtained, and evaporate the remainder by a gentle heat until reduced to a syrup. This will keep in closely stopped phials for years. When required for use, a little of it should be added to so much water as will give a test liquor of proper depth of colour. Test papers may be prepared from the alcoholic solution.—*Amer. Jour. of Science.*

28. *Use of Elderberries as a Chemical Test.*—Take a quantity of picked ripe elderberries, bruise them, and press the juice into a clean well-tinned vessel, add a fourth its weight of alcohol, and evaporate to one half; allow it to cool for ten or twelve minutes, add an equal bulk of alcohol, and strain the liquor through a fine cotton cloth from the precipitate which will form. The filtered liquor, now of a beautiful violet colour, is ready for use.

As trials of its sensibility, a drop of the tincture was added to a pint of rain water, the solution was so dilute that no blue colour could be perceived; but a single drop of sulphuric acid produced a decided red colour: a minute quantity of alkali was then added, which immediately changed the colour to a bright green. If only sufficient alkali be added to neutralize the acid, the original blue or violet colour is restored. This test, besides being very delicate, has the important advantage of keeping unaltered during the hottest season of the year. The species from which the above liquor was made was the Sambucus Canadensis; but it is probable that the juice of the common elderberry will answer the same purpose.—*Ann. of New York Lyceum.*

29. *Bleaching of Sponge, by* M. Vogel.—Chlorine rather increases than diminishes the colour of sponge. Sulphurous vapours do not act on it sufficiently. The sponges must first be soaked for several days in cold water, being frequently squeezed until the water ceases to be coloured, or rendered turbid by it. The water dissolves muriates, sulphates, and a brown animal matter insoluble in alcohol. They should then be washed in hot water; this removes hydriodate of potash from them, and if the washing-water be concentrated and moistened with strong sulphuric acid, it will render paper, moistened with solution of starch, of a blue colour; thus shewing the presence of iodine in sponges without burning them. When the sponges contain calcareous concretions, they are best removed by leaving

them for 24 hours in a mixture of 1 part muriatic acid, and 30 water. After being washed, they are to be put into a solution of sulphurous acid, sp. gr. 1034, and left for eight days, during which time, they are now and then to be squeezed. When well bleached, they are to be washed in much water, moistened with orange-flower water, and slowly dried in the air.—*Journ. de Phar.* x. 499.

30. *Cholesterine in human Bile.*—The existence of biliary calculi, composed entirely of cholesterine, induced M. Chevreul to ascertain whether bile did not always contain that principle. He obtained it by the following process. The bile, after having been diluted, filtered, and concentrated, was precipitated by alcohol; the alcoholic extract was acted upon by ether, and the latter solution left to crystallize spontaneously: a substance separated, which, when purified, was neither acid nor alkaline to vegetable colours, which like cholesterine crystallized, either when fused and cooled, or when dissolved in alcohol or ether. It required above 212° for its fusion, was not saponified by being boiled for 24 hours in solution of potash; in contact with sulphuric acid, instantly became of an orange red colour; and with nitric acid, behaved like cholesterine.

This cholesterine was from bile obtained from the body of a man who had died suddenly by a fall from a third story. Cholesterine was also found in the bile of eight other persons of different sexes, age, and who had died of different diseases, all contained also variable quantities of margaric and oleic acids.

All the biles examined, furnished the red substance, which had been first observed in the serum of the blood of infants attacked by jaundice and induration of the cellular tissue. This substance is insoluble in cold water, and nearly insoluble in alcohol and ether. It it very soluble in solution of potash; the solution has an orange colour, which by contact of oxygen changes, passing by yellow and yellow green. Nitric acid renders it blue, purple, red, and then yellow. Concentrated sulphuric acid makes it yellow, green, and at last blue, resembling indigo. It is considered, that the substance described is a colouring matter in a state of purity.

The bile of a bear gave a notable quantity of cholesterine, as well as of margaric and oleic acid. The bile of a pig gave a portion of what seemed to be cholesterine, and a greasy substance which appeared to be margaric and oleic acid.—*Mem. du Museum*, ii. 239.

31. *Electrical Conducting Power of Melted Resinous Bodies.*—It is commonly stated, that melted resins become good conductors of electricity, and freely allow of its transmission. The following experiments were made with the view of determining to what extent they possessed this property.

Common resin, shell-lac, asphaltum, bees'-wax, red and black

sealing-wax, were melted in separate glass tubes, fitted with wires for taking the electric spark: they all slowly and with difficulty drew off the charge of a jar, and not with the facility usually supposed. The melted contents of the same tubes acted as non-conductors, when made part of the Voltaic circuit.

Several thin glass tubes, (previously tried by metallic coatings,) were coated outside with copper foil, and about half filled with the melted substances, having wires dipping into them, similar to small Leyden vials. The resinous coating, however, distributed no charge over the interior of the glass tubes, when connected with the machine, which would have been the case with conductors.

Upon removing the copper coatings and wires, substituting pointed wires bent at right angles, resting against the interior of the glass tube beneath the melted bodies, and suspending them successively from an electrified conductor, placing a metallic rod outside opposite the points, sparks passed in all cases perforating the glass.

The last cases would indicate that melted resinous bodies are not conductors, and the results obtained in the first instance, may possibly be referred to heated air about the apparatus.

T. G.

III. Natural History.

1. *Volcano of Puracé—River containing free Acids.*—The following short abstract is from an important paper by M. Humboldt on the Volcano of Puracé, its geognostical relations and peculiar features. A river issues from it, which contains enough free muriatic and sulphuric acids, to render it slightly acid to the taste, from which circumstance it has received the name of Vinegar River from the inhabitants. The two volcanoes of Puracé and Sotara form part of the central chain of the Andes of new Grenada. Part of the way up the mountain, there is a small plain and a village, inhabited by some poor Indians who cultivate the ground. The village is named after the mountain and stands upon the edge of precipices, amongst which runs the river Pusambio or Vinegar River, forming three beautiful cascades. This river commences at a height of 1700 toises issuing from a very inaccessible place, and though at the lower cascades, it is not of a temperature above that of the atmosphere, yet, M. Humboldt has no doubt that its sources are very hot. The same thing is asserted also by the inhabitants of the place, and the traveller himself saw a column of smoke rise from the spot.

The waters are so injurious from the presence of the acids in them, as to destroy the fish in the river Cauca to some distance (four leagues) from the place where they first enter it: and it was found also, that persons who remain some time in the neighbour-

hood of the cascades formed by the river, experience a smarting and pain in the eyes from the effect of the minute spray in the air. The analysis, by M. Rivero, of this water, gave per litre (2.113 pints), sulphuric acid 16.68 grains; muriatic acid 2.84 grains; alumine 3.7 grains; lime 2.47 grains, and some indication of iron. The presence of muriatic acid, says M. Rivero, confirms the observations made on the vapours and stony productions of Vesuvius and other volcanoes. Other sources of similar water occur in the neighbourhood, which have been called the small vinegars. The specific gravity of the water of the larger river was 1.0015.

The volcano of Puracé is a dome of semivitreous trachyte, of a bluish gray colour and conchoidal fracture; it rises from a syenitic porphyry including common felspar, which in turn is superposed on transition granite abundant in mica. The volcano has not a large crater but many small mouths. On ascending it, and just upon the limit of perpetual snow, it was observed that the sulphur which occurred disseminated in the trachyte rock was increasing. Further on, a column of yellow smoke, and a fearful noise indicated the neighbourhood of one of the mouths of the volcano. It was difficult of approach in consequence of the steepness of the mountain and the occurrence of cracks covered only by a crust of sulphur, the thickness of which was unknown: the extent of the crust was estimated at 12,000 square feet.

The mouth of the volcano was a perpendicular opening, six feet long and three wide. It was covered by a crust of very pure sulphur in the form of a vault, eighteen inches in thickness, which the elastic vapours had broken open on the northern side. At the distance of twelve feet the warmth was agreeable, the thermometer rising to 60° F. nearly. The noise heard near this opening is almost always of the same intensity, and may be compared to that of many steam engines, the valves of which have been suddenly opened. By throwing stones, it was found, that within the crevice was a basin of water in ebullition. The vapours which escaped with so much violence were sulphurous acid, and it was soon found that the waters of the subterraneous lake were saturated with sulphuretted hydrogen. M. Humboldt had no means of determining the temperature of the vapours, but they appeared to be subject to extreme pressure in the interior of the volcano.

After several attempts, some water was obtained from the basin; it exhaled a strong odour of sulphuretted hydrogen, was not acid to the taste, and was slightly precipitated by nitrate of silver. The crust of sulphur over the basin is considered as produced by the mutual decomposition of the sulphuretted hydrogen and sulphurous acid. The water itself was observed covered by a film of sulphur.

Hence it appears, that the waters of this and other similar lakes on the volcano, have no analogy with the water of Vinegar river, except in the presence of a small quantity of muriatic acid; the

waters of the river, which issue forth much lower on the side of the mountain, contain free sulphuric acid, whilst the water from these lakes contain sulphuretted hydrogen. As the mouths are at very different heights, it may be considered that the waters in them do not communicate together, and arise from the melting of the snow.

The Vinegar river receives its acids from the interior of the volcano which abounds in sulphur, and of which the temperature appears to be very elevated, though for many ages no luminous phenomena have been observed on its summit.

The crust of sulphur which covers these mouths is said to increase to four feet in thickness in less than two years. The curate of the village sometimes directs the Indians to remove this crust, thinking that by thus cleaning the chimneys of the volcano, as he says, he is rendering a great service to his parishioners and to the neighbouring villages. Generally, the water in the basins stands at the same height, but in 1790, the great mouth caused partial inundations. These M. Humboldt distinguishes very strongly from such as are purely meteorological, as for instance, those of Vesuvius, where, though sometimes torrents of water laden with tufa and earthy matter descend, yet they originate, not from the crater or from apertures in the mountain, but from rain produced by the condensation of the vapours of the mountain.—*Ann. de Chimie*, xxvii. 113.

2. *Sulphur Mountain of Ticsan.*—" In following the Cordillera of the Andes towards the south," says M. Humboldt, " what was my surprise, when on the other side of the equator, I found that the celebrated *sulphur mountain of Ticsan* (lat. 2° 10′ S.) between Quito and Cuença, was not composed either of trachyte or limestone, or gypsum, but of mica slate. This mountain of sulphur, called *Quello* by the Indians, is, according to my barometric measurement, 1250 toises above the sea. It is composed entirely of primitive mica slate, which is not even anthracitic as are the transition varieties of this rock. In the ravines between Ticsan and Alausi, it is seen reposing on gneiss. The sulphur is contained in a bed of quartz more than 1200 feet thick, regularly directed N. 18° E., and inclined like the mica slate 70° or 80° to the N.W. The bed of quartz is worked open to-day. The side of *Cerro Quello*, in which the works were commenced ages ago, is opposed to the S.S.E., and the bed appears to prolong itself towards the N.N.W. At the same time, sulphur has not been found at the surface of the earth in that direction, at 2000 toises from Ticsan. The whole is covered by a thick vegetation."

Towards the end of the eighteenth century, masses of sulphur were found from two to three feet in diameter; at present, strata much poorer are worked, the sulphur being disseminated through them in lumps from three to four inches in thickness. It is observed, that the sulphur increases in quantity with the depth of the

works, but these are arranged so badly, that the lower strata are almost inaccessible. As the quartz contains no fissures or cavities, no specimens of crystallized sulphur have been found.

The sulphur does not form, as might perhaps have been supposed, a mass or collection of veins, but is disseminated in small masses, having no continuity with each other, in the quartz which traverses the mica slate parallel to its strata. The apertures, by which perhaps they have been united, are no longer visible; but all the quartz has suffered a singular change. It is dull, frequently friable, and breaks in some places with the slightest blow, which indicates splits or cracks, which are inappreciable to the sight. The temperature of the rock does not differ from that of the atmosphere. The inhabitants are in the habit of attributing the earthquakes to which their country has been exposed, to the concavities which they suppose to exist beneath the sulphur mountain. In the great catastrophe of the 4th of February 1797, which destroyed so many thousand Indians in the province of Quito, the three places where there is most sulphur, the Cerro Quello, the Azufral de Cuesaca near the town of Sbarra, and the Machay of St. Simon, near the volcano of Antifana were only slightly agitated; but at a previous period, an explosion resembling that of a mine occurred in the bed of quartz itself, which contains the sulphur near Ticsan.—*Ann. de Chim.* xxvii. 131.

3. *Volcanic Saline Matter.*—An enormous mass of saline matter was thrown out of Vesuvius during the eruption of 1822. It was to the eye a mixture of two substances; the one white crystalline, lamellar and friable; the other a hard brown red substance, containing evidently oxide of iron. The white substance, separated mechanically, was principally muriate of soda and potash mixed with a little sulphate of lime. A fair sample of the whole mass, when analyzed by M. Laugier, gave

Soluble in cold water,	Muriate of soda	62.9
	Muriate of potash	10.5
	Sulphate of lime	0.5
Soluble in hot water,	Ditto	0.6
	Sulphate of soda	1.2
Insoluble in water,	Silica	11.5
	Oxide of iron	4.3
	Alumine	3.5
	Lime	1.3
	Water and loss	3.7
		100.0

The quantity of salt present, induced many of the poor people of Naples and the neighbourhood to store up portions of the mass for their domestic uses.—*Ann. de Chim.* xxvi. 371.

4. *Obsidian.*—At the volcano of Sotara, between Bogota and Quito, M. Humboldt observed the neighbouring plains of Julumeto covered with balls or tears of obsidian, thrown out by the volcano. These were frequently tubercular on the surface, and occurred of all shades of colour, from the deepest black to the most perfect and colourless transparency. These varieties of colour were not accompanied by any swelling or want of compactness. The specimens were mixed with fragments of enamel, resembling Reaumurs' porcelain, and to which unfused pieces of feldspar adhered.—*Ann. de Chim.* xxvii. 117.

5. *Locality of the Columbite.*—Dr. Torry, of New York, has discovered Columbite, massive and crystallized, in a rock from Haddam, (Connecticut), and he thinks it is probable that the specimen in the British Museum, in which Mr. Hatchett originally discovered columbium came from the same place. That specimen is said to have been found in New London, not above 25 miles from Haddam, and though a much larger piece than any as yet found at the latter place, yet he observes, it is probable that a close examination will furnish finer specimens than any that have been found there.

6. *Erlanite*, a New Mineral.—This mineral was observed by Breithaupt, in 1818, in different parts of the Saxon Erzgebirg. It forms a part of the oldest gneiss formation, and is always mixed with more or less mica. Between Grose-Pöhle and Erla there exists a bed of it, at least 100 fathoms in thickness. It has been used for upwards of 200 years as a flux by the iron smelters, and until its examination by Breithaupt it had been uniformly mistaken for limestone.

Characters—Lustre, feeble shining to dull; streak, shining with a fatty lustre; colour, light greenish grey; streak, white massive:—sometimes compact, sometimes in small and fine granular distinct concretions; fracture, in some specimens foliated, in others splintery and even; structure distinctly crystalline, but as yet no regular cleavage obtained; hardness between that of apatite and actionolite; specific gravity from 3 to 3.1. Before the blow-pipe readily melts into a slightly coloured, transparent, compact bead. It resembles gehlenite more than any other mineral; is distinguished from felspar by greater specific gravity, and from saussurite by inferior specific gravity and hardness. It is composed, according to Gmelin, of

Silica .	53.160	Oxide of Manganese	0.639
Alumina .	14.034	Volatile matter	0.606
Lime .	14.397	Loss . .	1.995
Soda .	2.611		
Magnesia .	5.420		100.000
Oxide of Iron	7.138		

Ann. Phil. N. S. viii. 389.

7. *Native Sulphate of Uranium.*—Dr. John has observed the existence of native sulphate and sub-sulphate of uranium, in Elias mine, a short distance from Joachimsthal in Bohemia. The sulphate is crystallized in flat prisms, from one to three lines in length, of an emerald-green colour, glossy lustre, transparent, though sometimes opaque, brittle, and soluble in water. The sub-sulphate occurs as a thin crust, of an intense sulphur-yellow colour, on other uranium minerals. It is friable, partly soluble in water, and entirely in nitric acid.

8. *On a mode of Planting through Trees.*—A memoir, by M. A. Thouin, on the mode of planting through trees has been published in the *Mém. du Muséum*, ii. 161. Reference is first made to the statement of Pliny, that he had seen in the grounds of Tullius, at Tibur, a tree grafted in all possible methods, and bearing all kinds of fruit: one branch was covered with nuts, another with berries, (cherries, prunes, *&c.*) another with grapes, another with figs, another with pears, another with pomegranates, and finally others with all sorts of apples; the life of this tree was of but short duration.

M. Thouin, after remarking on the impossibility of the effect described by Pliny, as produced by grafting, describes other processes by which it may perhaps have been obtained. He notices the singular results produced by the growth of parasitic plants on others, or of certain plants, in the decomposed and decomposing wood of trees; also the effects produced by the association of twining, trailing, and creeping plants, either together or around forest trees, where, after many years, the fasciculus of many trunks appears so much like one trunk as to deceive even persons of some experience. He then proceeds to remark on an effect sometimes produced in Italy, and still more deceptive than any of the above. The gardeners of Genoa, Florence, Venice, *&c.*, choose an orange-tree, which they deprive of its branches; the trunk is then perforated through its whole length, and through the roots to the ground beneath. They then select young plants of the jasmine, the dwarf almond with double flowers, fig-trees, rose-trees, myrtles, and other ornamental plants, and these being arranged in twos, or threes, according to fancy and the size of the aperture in the orange-tree, are planted either in the ground or in a tub, according to the climate, passing them through the orange tree, so that the plants may reach a short distance above the upper end of the trunk; the roots of the tree are then covered with earth, watered, and cultivated, as if it were a tree just planted. The tree and the young plants all grow together, and will live for ten or fifteen years.

This experiment was repeated by M. Thouin, at the agricultural school. A tilleul (linden tree,) 11.8 inches in diameter, was taken up with parts of its roots, and cut horizontally about the height of forty inches; the roots were shortened to about twenty inches, and the fibres thinned, or entirely removed, where too abundant. The

trunk was then bored and converted into a cylinder, having an internal diameter of about six inches, the fresh wood being trimmed so as to remove any broken parts. The young trees were seven in number, raised from seeds, aged from two to four years, having strong roots and straight stems, about sixty-four inches long. They were of very different families. The roots were trimmed, the branches removed, and the extremities of the stems cut off. These were planted on March 15, 1813, in a circular hole, a yard and a half in diameter, the roots being led outwards and the stems being lightly tied together: a little earth was then sprinkled over them, and afterwards the perforated trunk put in its place, being let down over the young plants, the stems of which were guided through it. Good earth was then put in amongst the roots, and the ground covered up and well watered. After being planted, the stems of the small plants were retained at an equal distance from each other, and from the sides of the aperture, by pads of moss, inserted at the aperture; and a direction outwards was given to them, by fastening them to a hoop. The plants were watered in times of dryness or of heat with muddy water, four or five holes being made about the group, that the air and water might have access to the roots of the young plants. In order to equalize the growth of the plants, that one might not rob another, such as were most vigorous were deprived of their small branches and buds; and sometimes the stems were bent so as to prevent the sap from circulating with too much facility. During the winter, the weakest plants were cut short, that the few buds left might receive a greater accession of nutriment, while the stronger ones were left of greater length. The trunk of the tree, though perforated completely, threw out many buds on its surface; these were left to grow the first year, but in after years those branches were removed which interfered with the other plants. Such was the growth of the plants thus enclosed, that in a few years they entirely filled the cavity of the perforated tree, after which the sap not being able to return freely to the roots, a swelling was formed at the top of the old trunk, which after some time expanded, so as to make every trace of the cavity covered by it, disappear. It was then necessary, for other reasons, to cut down this group of trees; but had it remained, there is no doubt but the different plants would soon have yielded fruit, probably to an excessive degree, from the hindrance to the return of the sap.

This experiment was varied by cutting a tree while standing so as to leave a trunk between six and seven feet long; it was bored as it stood, as low as the roots, and then holes were made through the side; the young plants were then introduced through these holes, which were afterwards covered with earth, *&c.*

M. Thouin is quite convinced that it was by an operation of this kind that the tree, or collection of trees, which Pliny speaks of, was produced.

9. *Preservation of Seeds.*—The late Dr. Roxburgh, when in India, appears to have been in the habit of putting up the various seeds, which, among other things, he wished to send home to this country, in an envelope of gum-arabic: they were coated with a thick mucilage of gum, which hardened around them: and he was informed by Sir John Pringle, the President of the Royal Society, that the seeds had been received in a better state of preservation, particularly the mimosas, than he had ever seen the same kinds arrive from countries equally distant.— *Tech. Rep.* vi. 299.

10. *Ammonite, &c. containing Shells.* Communicated by the Rev. C. P. N. Wilton, B.A., F.C., P.S., of Blakeney, Gloucestershire.—In page 188 of the last Number of the *Journal of Science, Literature, and the Arts*, a communication is made of the discovery of an ammonite containing shells, on a hill near *Alais*. A similar circumstance has lately presented itself to my notice, on the western shore of the Severn, in the parish of Aure, in the county of Gloucester. At a part of the shore, called the *Woodend*, a very great variety of organic remains are found in the Blue Lias; amongst the rest was lately discovered a large fragment of an ammonite in limestone, which must have been about nine inches in diameter, having in its interior several other shells of *serpula, spines of echinus, ostrea, pectunculus*, and *pentacrinite* mixed together, in the mass of which the ammonite is composed. In the chalk of the upper formation of the South Downs, in Sussex, in a pit on the side of that part of them which is called *Heyshott-hill*, near the town of *Midhurst*, I have noticed a similar occurrence of the appearance of shells imbedded in the interior of another, of a different species. In breaking a large mass of angular flint, the fracture passed through a shell of the *echinus mamillaris*, the interior of which was filled with black flint, and in the substance of the flint, which formed the interior of the echinus, were imbedded three minute bivalves of the species, *terebratula dentata*.

11. *Ficus Elastica.*—M. Caventou has examined the *ficus elastica* analytically, with a view to detect the presence, and ascertain the quantity, of caoutchouc in it; but could not discover that it contained any of that substance.

12. *Form of Hail-stones.*—Whilst ascending the Volcano of Puracé, in the Andes, M. Humboldt had occasion to observe, that during a hail-storm, the hail stones, which were white, from five to seven lines in diameter, and formed of layers of different translucency, were not merely very much flattened at the poles, but were so much swelled in their equatorial dimensions as to have rings of ice separate from them on the slightest blow. M. Humboldt had twice previously observed this phenomenon in the mountains of Bareuth and near Cracovia, during a journey in Poland. "May it be admitted

that the successive layers which are added to the central nucleus are in a state of fluidity sufficient to allow of the flattening of the spheroids being caused by a rotatory movement ?"—*Ann. de Chim.* xxvii. 120.

13. *On the causes of Animal Heat.*—The following are some of the conclusions obtained by M. Despretz, during the course of his experimental investigations of the causes of animal heat:—

1. Respiration is the principal cause of the developement of animal heat; assimilation, the motion of the blood, the friction of various parts, may produce the small remaining portion.

2. Besides the oxygen employed in the production of carbonic acid, another portion of this gas, which is sometimes very considerable in proportion to the first, also disappears; it is supposed generally, that it is employed in the combustion of the hydrogen of the blood. In general more oxygen disappears in the respiration of young animals than in that of adults.

3. Exhalation of nitrogen takes place in the respiration of those mammiferous animals which are carnivorous or frugivorous, and in the respiration of birds; the quantity of nitrogen exhaled being greater in frugivorous than in carnivorous animals.—*Ann. de Chim.* xxvi. 360.

14. *Hydrophobia.*—Dr. Capello, of Rome, in a memoir, read before the Academy dei Lincei, affirms that the hydrophobic poison, after its first transmission, loses the power of conveying the disease. This observation, already made by Bader, is confirmed by repeated experiments made by Dr. Capello. A lap-dog and cat were both inoculated with the saliva of a dog who died of *inoculated* hydrophobia; they both remained free from disease, and three years afterwards the lap dog was again inoculated from a dog who became rabid spontaneously; he then took the disease and died.

An ox was bitten by a dog attacked with rabies; he became hydrophobic, and bit many other animals: all remained free from the affection. The dog that bit the ox also bit a child, who died about four months after, with all the symptoms of hydrophobia: with the saliva of this child a dog was inoculated, but the disease was not transmitted.

A dog which had been bitten by another dog became hydrophobic on the fifty-first day, broke the chain with which he was fastened, and escaped into the street, where he bit many persons, and the dogs of two persons (who are named), and finally disappeared among the ruins of the Villa of Quintilius Varus; not one of the persons or dogs so bitten had the slightest symptom of hydrophobia.—*Med. Jour.* lii. 433.

15. *Use of Pomegranate Root as an Anthelminthic.*—Dr. Chapotin says, boil an ounce and a half, or two ounces, of the dried bark of

the pomegranate-root in two pints of water, and evaporate to twelve ounces; two ounces are to be given every half hour; the worm (tænia) is often expelled in twelve hours after the first bottle of decoction. If this does not happen on the first or second day, the same means are continued for four or five days in succession, but must be discontinued as soon as giddiness is felt by the patient. A dose of castor oil is generally given after the fourth bottle of the infusion, even though the worm should have been expelled.

The powdered bark of the root may also be used in doses of a scruple per day, for infants, and twice that quantity for adults, the powder being given in small portions, at intervals of half an hour.—*Jour. de Phar.* x. 502.

16. *Power of Vegetable Life.*—A branch of the *cotyledon coccinea* was presented by Professor Gazzari to the Accademia dei Georfiles, in Jan. 1824. Although it had been separated from the mother branch more than sixteen months, during which time it had been wrapped up in paper and set aside by accident in a dark dry place, yet it was in full vegetation, affording a strong illustration of the vital power of some plants.—*Revue. Encyclop.* xxiii. 757.

17. *Note on a singular Psycho-physiological Phenomenon*, by M. F. Chavannes.—The note of which the following is an abstract, was sent to the Society of Natural Sciences of Switzerland, and is inserted in the Bibliothèque Universelle, xxvii. 160. M. Chavannes, whilst residing during last summer at Wuarrens, near Echallens, had occasion to hear some account of a man, who, without any uncertainty or mistake, could indicate the precise hour by day or night, and even the minutes and seconds; and this, it was said, he did by consulting his pulse. Induced by these reports to make close inquiry as to their foundation, he visited the man and obtained the following results.

His name is Jean Daniel Chevalley, age 67 years. In his youth, the ringing of bells and vibrations of pendulums constantly attracted his attention; and he gradually contracted a habit of counting isochronous vibrations, and displayed considerable ability in calculations. When strong enough, he took pleasure in sounding the bells at school and church; and in his attention to town and church clocks, observed that the beats were 20 or 23 per minute, but more particularly 20, counting from the moment of departure to that of return. After this, he endeavoured to force his attention to the preservation as long as possible of an *internal movement*, similar as to the extent of time and number of vibrations. " At first," he says, " by adding 20 vibrations to other 20, or minute minute, he could easily arrive at the conclusion of an hour, and mark all the sub-divisions which he wished, and that without confusion; but the thoughts and corporeal occupations suffered by this attention. By degrees, I was able to count whilst thinking

and acting; but I could not proceed far, because my mind, making a certain effort for a length of time, though but slightly sensible to myself, became fatigued, and dropped the chain of calculation. Nevertheless, in 1789, I succeeded in acquiring the invariable possession of this faculty, which has never since left or deceived me."

He was then 22 years of age, and occupied at a school; but in consequence of some singular habits, as that of sounding bells, and of some mystical notions he had acquired, and also certain disputes about the correction of the village clocks, he was dismissed and went to his mill, where, continuing to sound his bells and make his clocks strike, he was nick-named the Mummy of the Mill.

Being on board the steam-boat on the lake of Geneva, (July 14, 1823,) he soon attracted attention by his remarks, *that* so many minutes and seconds had passed since they had left Geneva, or passed other places; and, after a while, he engaged to indicate to the crowd about him the passing of a quarter of an hour, or as many minutes and seconds as any one chose, and that during a conversation the most diversified with those standing by; and further to indicate by the voice, the moment when the hand passed over the quarter minutes, or half minutes, or any other subdivision previously stipulated, during the whole course of the experiment. This he did without mistake, notwithstanding the exertions of those about him to distract his attention, and clapped his hands at the conclusion of the time fixed.

M. Chavannes then reverts to his own observations. The man said, "I have acquired by imitation, labour, and patience, an internal movement, which neither thoughts nor labour, nor any thing can stop; it is similar to that of a pendulum, which at each motion of going and returning gives me the space of three seconds, so that twenty of them make a minute, and these I add to others continually." The calculations by which he obtained subdivisions of the second were not clearly understood by M. Chavannes, but the man offered freely to give proof of his power. On trying him for a number of minutes, he shook his head at the time appointed, altered his voice at the quarter, half, and three-quarter minutes and arrived accurately at the end of the period named. H seemed to assist himself in a slight degree by an application oı mnemonics, and sometimes, in idea, applied religious names to his minutes up to the fifth, when he re-commenced; this he carried through the hour and then commenced again. On being told that the country people said he made use of his pulse as an indicator, he laughed at the notion, and said it was far too irregular for any such purpose.

He admitted that his internal movement was not so sure and constant during the night, "nevertheless it is easy to comprehend" he said, "that when I have not been too much fatigued in the evening, and my sleep is soft, if, after having awakened me without

haste, you ask me what the hour is, I shall reflect a second or two, and my answer will not be ten minutes in error. The approach of day renews the movement if it has been stopped, or rectifies it, if it has been deranged, for the rest of the day." When asked how he could renew the movement when it had ceased, or was very indistinct, he said " Sir, I am only a poor man, it is not a gift of heaven; I obtained this faculty as the result of labours and calculations too long to be described; the experiment has been made at night many times, and I will make it for you when you please." M. Chavannes had not, however, the opportunity of making this experiment, but he felt quite convinced of the man's powers. He states that the man is deaf, and cannot hear, at present, the sound of his clock or watch; and further, that neither of these vibrate twenty times in a minute, which is always the number indicated by the motions of Chevalley when he wishes to illustrate his internal movement; and he is convinced, according to what he has seen, that *this man possesses a kind of internal movement, which indicates minutes and seconds with the utmost exactness.*

ART. XVII.—METEOROLOGICAL DIARY for the Months of September, October, and November, 1824, kept at EARL SPENCER's Seat at Althorp, in Northamptonshire.

The Thermometer hangs in a North-eastern Aspect, about five feet from the ground, and a foot from the wall.

For September, 1824.

		Thermometer.		Barometer.		Wind.	
		Low	High	Morn.	Eve.	Morn.	Eve.
Wednesday	1	52	78	29.87	29.87	NE	SbW
Thursday	2	53	81.5	29.90	29.88	SW	SE
Friday	3	54	82.5	29.88	29.83	SE	SW
Saturday	4	60	75	29.74	29.74	SW	W
Sunday	5	46	70	29.65	29.70	W	W
Monday	6	55	69	29.40	29.32	SE	WbS
Tuesday	7	53	70	29.36	29.39	SW	SW
Wednesday	8	50	64	29.33	29.33	ENE	WbS
Thursday	9	48	63	29.50	29.58	W	NW
Friday	10	39	66	29.61	29.64	NW	SbE
Saturday	11	53	69	29.55	29.58	SE	W
Sunday	12	55	68	29.49	29.60	W	W
Monday	13	47	68	29.84	29.92	W	SW
Tuesday	14	54	70	29.84	29.84	SSW	SSW
Wednesday	15	60	70	29.88	30.00	WbN	W
Thursday	16	41	68	30.08	30.08	W	W
Friday	17	45	69	30.09	30.04	W	SE
Saturday	18	52	71	29.99	29.90	SE	SE
Sunday	19	52	68	29.80	29.79	W	WbN
Monday	20	51	62	29.74	29.75	NW	NW
Tuesday	21	46	58	29.73	29.74	W	WbN
Wednesday	22	50	65	29.90	29.98	NE	NE
Thursday	23	53	59	29.87	29.87	NW	WbN
Friday	24	51	64	29.90	29.94	NbE	NW
Saturday	25	54	61	29.94	29.80	NW	NW
Sunday	26	39	54	29.90	29.80	NW	NW
Monday	27	38	54	29.50	29.48	W	WbN
Tuesday	28	32.5	53	29.60	29.73	WbN	NW
Wednesday	29	27	58	29.74	22.70	WbN	SE
Thursday	30	41	67	29.51	29.30	SE	SE

For October, 1824.

		Thermometer.		Barometer.		Wind.	
		Low	High	Morn.	Eve.	Morn.	Eve.
Friday	1	58	59	29.10	29.00	SE	WbS
Saturday	2	45	59	29.17	29.20	SE	SW
Sunday	3	47	62	29.55	29.66	SW	SW
Monday	4	49	62	29.69	29.66	SW	E
Tuesday	5	51	60	29.51	29.47	E	ESE
Wednesday	6	54	62	29.37	29.30	E	SE
Thursday	7	55	64	29.14	29.14	E	S
Friday	8	54	65	29.14	29.25	S	WbS
Saturday	9	54	62	29.25	29.43	WbS	W
Sunday	10	45	60	29.43	29.10	E	E
Monday	11	44	56	28.83	28.81	E	SE
Tuesday	12	43	46	28.81	29.00	NE	N
Wednesday	13	32	47	29.20	29.31	NW	W
Thursday	14	34	48	29.37	29.43	W	WbN
Friday	15	40	43	29.50	29.60	NW	NW
Saturday	16	28.5	44	29.70	29.80	NW	NW
Sunday	17	30	49	29.83	29.91	WbN	N
Monday	18	28	51	29.96	29.96	W	W
Tuesday	19	34	55	29.94	29.87	WSW	WNW
Wednesday	20	48	58	29.81	29.88	WSW	WSW
Thursday	21	42	55	29.90	29.84	W	SSE
Friday	22	41	58	29.80	29.73	SE	S
Saturday	23	54	61	29.74	29.82	W	W
Sunday	24	45	61.5	29.76	29.60	E	SE
Monday	25	55	61	29.41	29.41	SE	SE
Tuesday	26	48	52	29.16	29.10	SE	W
Wednesday	27	46	56	29.27	29.43	W	W
Thursday	28	41	55	29.48	29.50	W	WbS
Friday	29	43	52	29.53	29.40	W	WNW
Saturday	30	40	47	29.70	30.00	W	W
Sunday	31	34	50	29.83	29.67	WbS	W

For November, 1824.

		Thermometer.		Barometer.		Wind.	
		Low	High	Morn.	Eve.	Morn.	Eve.
Monday	1	48	56	29.53	29.50	SW	W
Tuesday	2	51	58	29.55	29.32	W	W
Wednesday	3	41	50	29.60	29.63	W	W
Thursday	4	37	43	29.63	29.63	NW	NW
Friday	5	33	41	29.60	29.68	W	WbN
Saturday	6	28	43	29.87	29.90	W	S
Sunday	7	42	56	29.78	29.73	SW	SW
Monday	8	49	57	29.53	29.47	SSE	SSW
Tuesday	9	36	46	29.79	29.79	W	WbS
Wednesday	10	45	54	29.67	29.55	WbS	WbS
Thursday	11	50	55	29.62	29.60	WbS	W
Friday	12	40	48	29.70	29.82	W	W
Saturday	13	38	55	29.87	29.55	SW	SW
Sunday	14	45	46	29.35	29.35	WbS	W
Monday	15	38	45	29.62	29.86	W	WbN
Tuesday	16	31	49	29.98	29.80	SW	SW
Wednesday	17	40	54	29.60	29.40	W	SW
Thursday	18	50	57	29.15	29.38	SW	WbS
Friday	19	37	48	29.53	29.55	SW	SW
Saturday	20	36.5	47	29.42	29.27	E	SW
Sunday	21	40	48	29.27	29.24	S	SSE
Monday	22	37	44	29.19	29.20	SW	S
Tuesday	23	42	48	28.32	28.26	SE	SW
Wednesday	24	43	48	28.72	28.87	SW	SW
Thursday	25	38	46	29.07	29.28	WbS	W
Friday	26	30	45	29.48	29.50	W	NE
Saturday	27	31	41	29.58	29.60	S	ESE
Sunday	28	35	50	29.47	29.24	SW	SSW
Monday	29	44	49	28.98	29.13	SW	W
Tuesday	30	36	50	29.28	29.02	WbS	W

INDEX.

Errors in Mr. Swainson's Paper in No. XXXIII.

Page 15, line 15 from the bottom, for *cleared* read *cleaned*.
„ 8 do. after " depressed" a comma.
16, note, for Zoologiæ read *Zoological*.
31, line 18, for *Sec.* read *Sw*.
32, for Voluta gracil*us* read Voluta gracil*is*.
33, line 16, for *Island* read *Islands*.
" 20, for *spira* read *spiræ*.
35, 1 line from the bottom, for columell*a* read columell*â*.
2 do. for sutur*a* read sutur*â*.
37, line 12, for *crenated* read *carinated*.
„ 17, for *alba* read *albâ*.
„ 23, for *turned* read *tumid*.
„ 3 lines from the bottom for *tusque* read *tûsque*,
and for *vasalis* read *basalis*.

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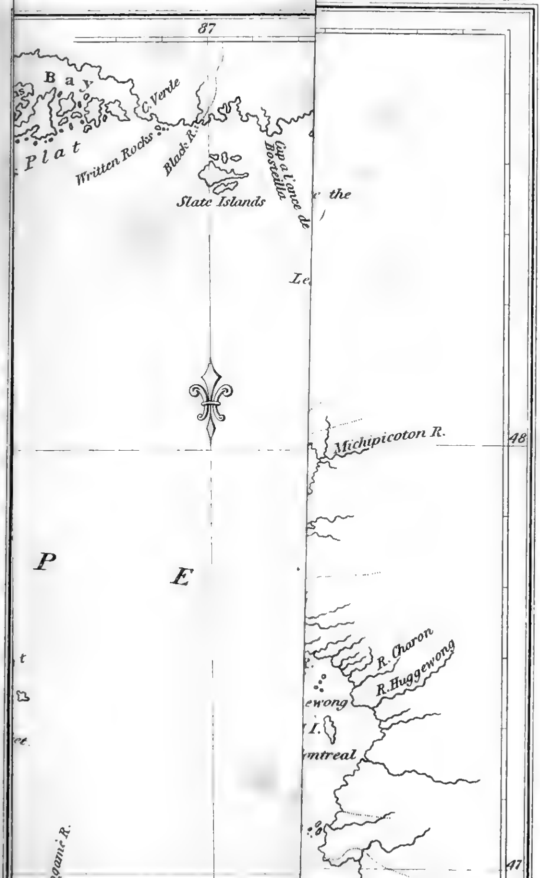

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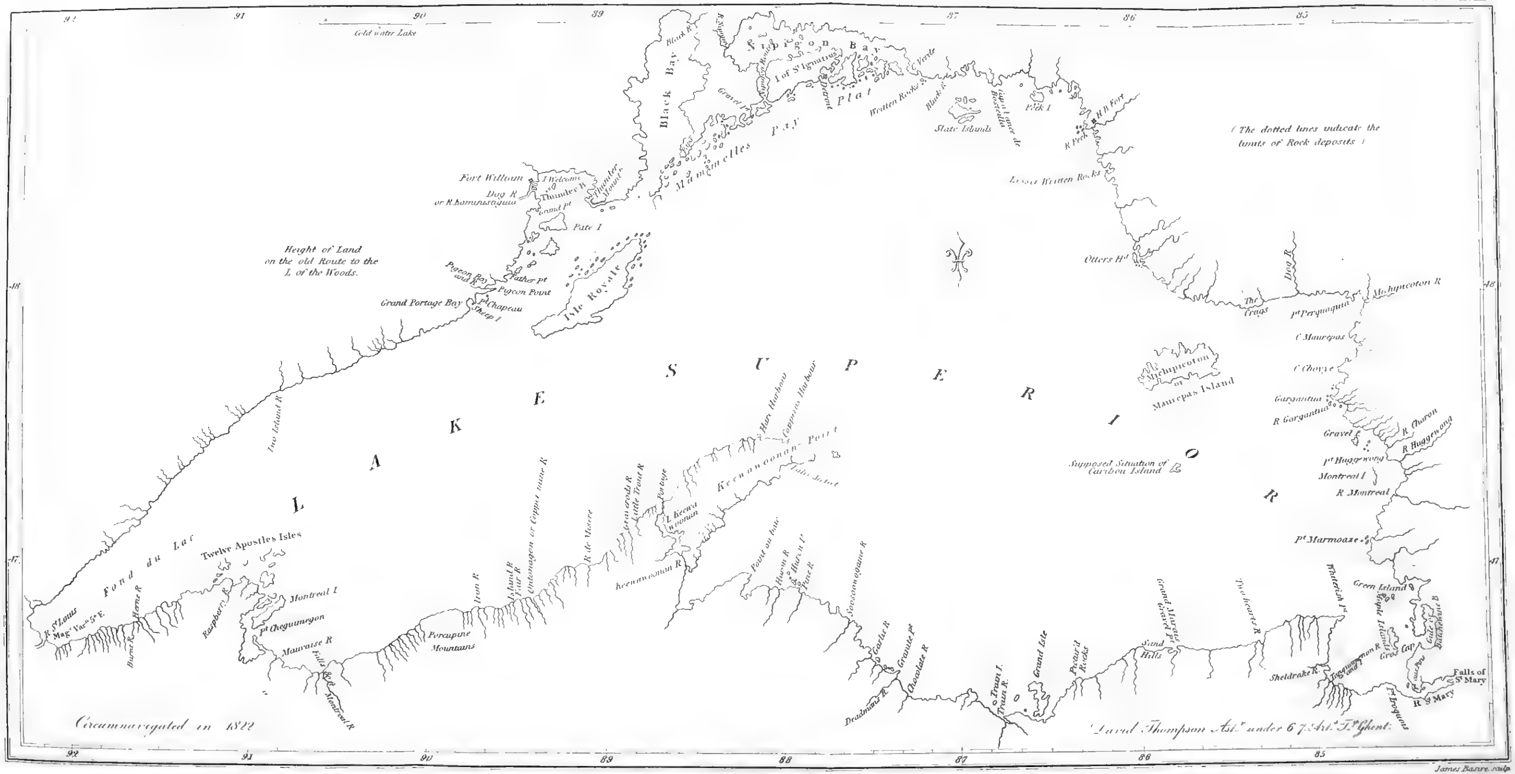

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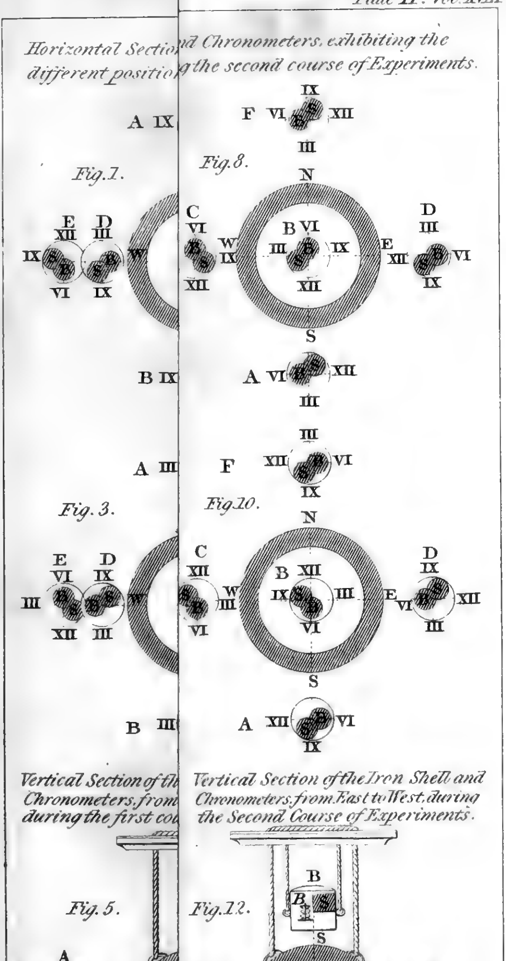

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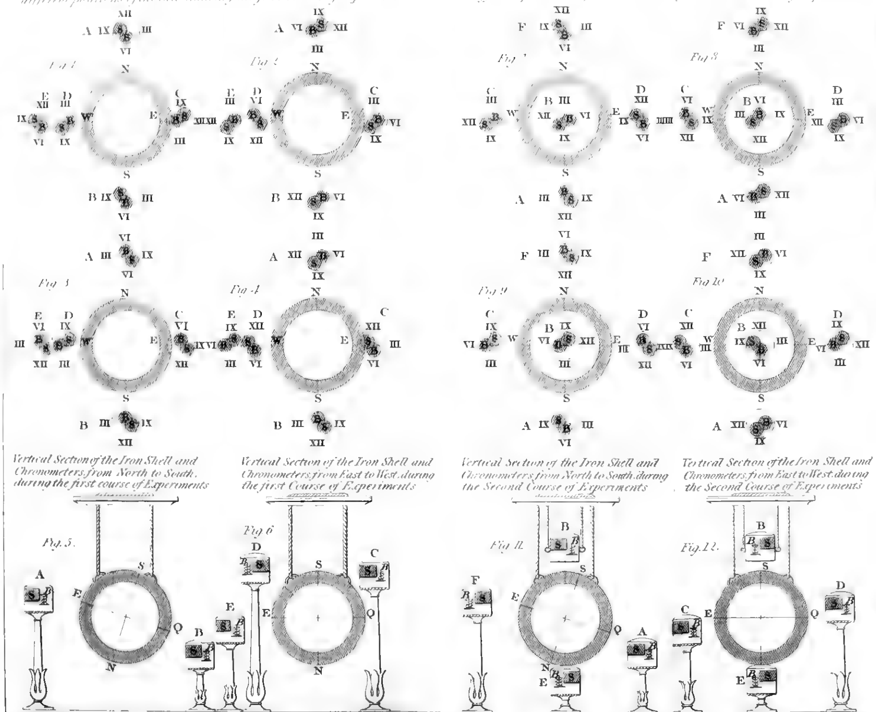
Horizontal Sections of the Iron Shell and Chronometers, exhibiting the different positions of the latter, during the first course of Experiments

Horizontal Sections of the Iron Shell and Chronometers, exhibiting the different positions of the latter, during the second course of Experiments



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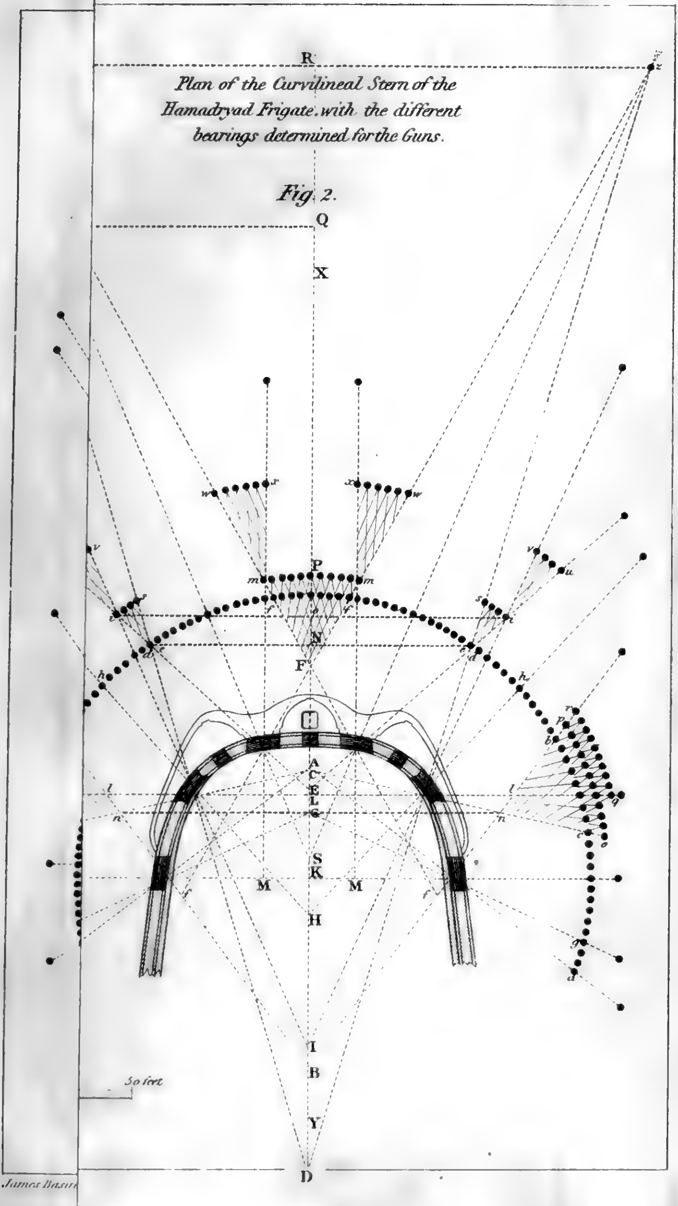
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Plan of the Curvilineal Stern of the
Hamadryad Frigate with the different
bearings determined for the Guns.
Fig. 2.
Q
X
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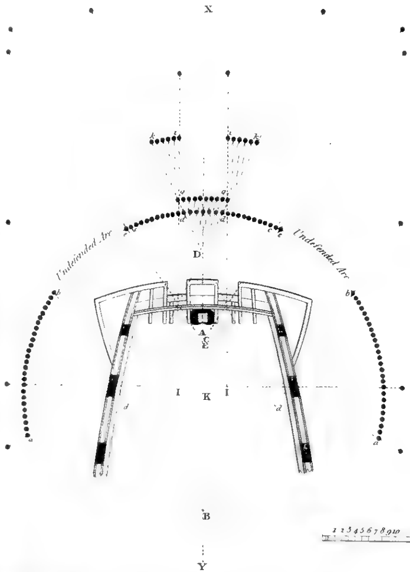
50 feet
James Basire

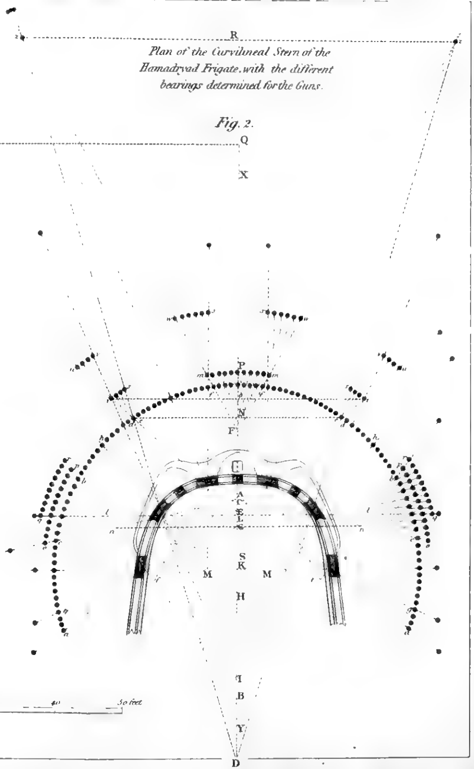
Plan of the Square Stern of the Boadicea Frigate, with the different bearings determined for the Guns.

Fig. 1.



Plan of the Curvilineal Stern of the Hamadryad Frigate, with the different bearings determined for the Guns.

Fig. 2.



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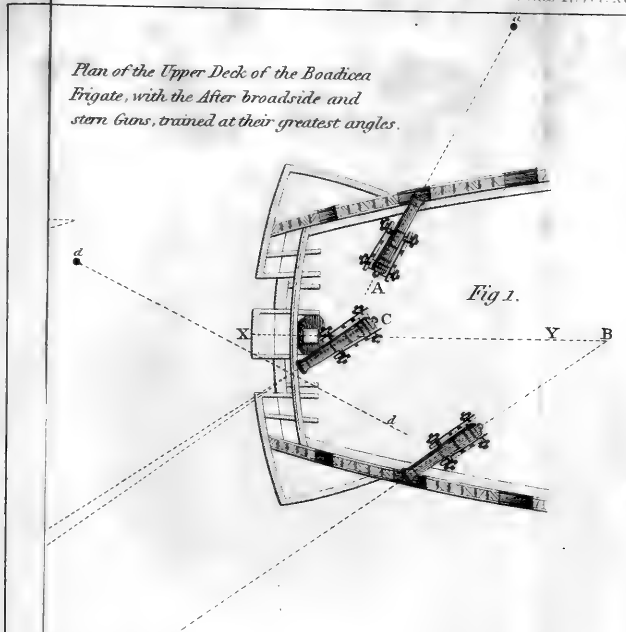

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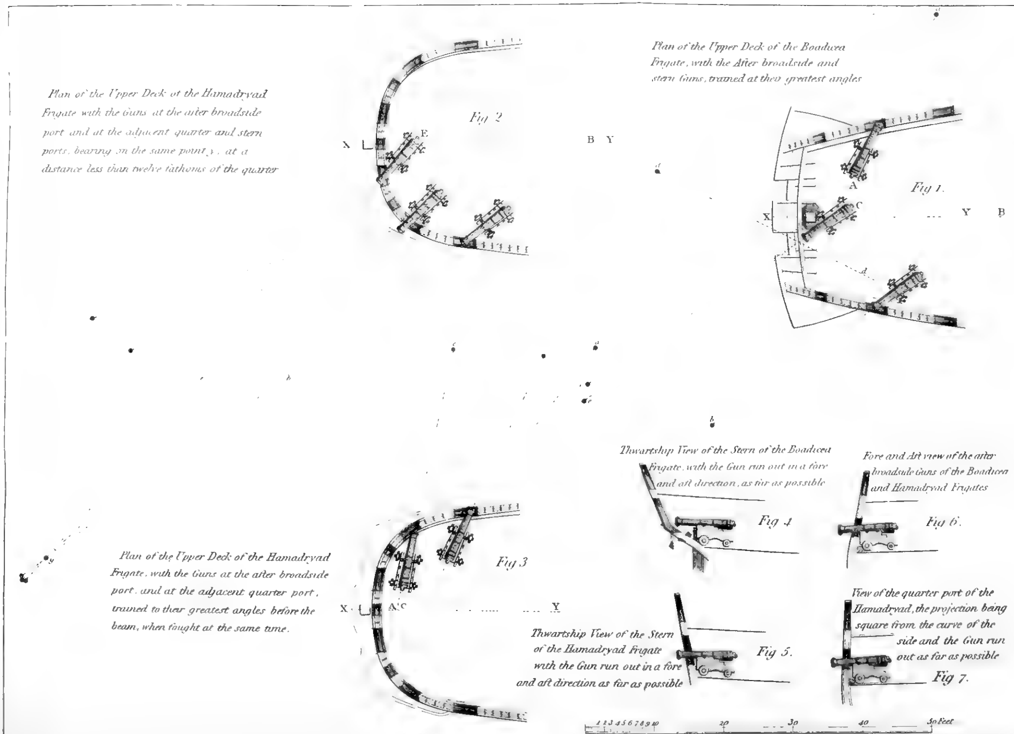

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